THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 52 Thursday, March 28, 1935 No. 971

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1933-34.

Roy Stubbs, 36, Broadway, Cheadle, Cheshire.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: L. W. Bolton, 21-23, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.
London: H. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.
Newcastle-upon-Tyne: W. Scott, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.
East Midlands: H. Bunting, 82, Otter Street, Derby.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth: J. J. McClelland, 122, Wellington Road, Bilston, Staffs.
Middlesbrough: D. Anderson, 24, Stockton Street, Middlesbrough.
Preston: P. Leyland, 6, Ashley Terrace, Farington, Lancs.
Lincoln: E. R. Walter, "Cavalla," Erntwell Road, Lincoln.
Burnley: J. Pell, 17, Mersey Street, Rose Grove, Burnley, Lancs.
Falkirk: H. McNair, 14, Seabegs Crescent, Bonnybridge, Scotland.

National Ironfounding Employers' Association

President: J. Smith, Smith & Company (South Shields), Limited, Mile Street, South Shields.
Secretary: Harold G. Judd, C.B.E., 8, Frederick's Place, E.C.2.

The Institute of Vitreous Enamellers

President: Dr. J. W. Mellor, F.R.S., Stoke Technical College, Stoke-on-Trent.
Chairman: W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary: Miss E. Christine Elliot, Davis Street, Cubitt Town, E.14.

Foundry Trades' Equipment and Supplies Association

President: R. H. Brackenbury, 13, Victoria Street, London, S.W.1.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary: E. J. Griffiths, 2, Royal Metal Exchange, Swansea

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Central 1885. *Telegrams: CIRA*

The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

Contents

	PAGE
The Federation Dinner	215
The Foundry Exhibition	215
Correspondence	216
The Qualcast Dinner	216
Catalogues Received	216
Company Meeting	216
Random Shots	216
Free and Hindered Contraction of Cast Carbon Steel	217
Foundry Trades' Equipment and Supplies Association	218
Publication Received	218
Heat-Treated Grey-Iron Cylinder Liners	219
Iron and Steel Institute	220
Recent Advances in the Founding of Aluminium Alloys	221
The British Iron and Steel Federation	224
Refractories Association	226
British Standard Pump Tests	226
This Week's News in Brief	228
Trade Talk	228
Contracts Open	228
Company Reports	228
Personal	228
Obituary	228
New Companies	228
Raw Material Markets	230

The Federation Dinner

The increased tariff on imported iron and steel, which we predicted in a recent issue, was announced on the eve of the annual dinner of the British Iron and Steel Federation, at which H.R.H. the Prince of Wales was the principal guest. The gesture has been followed by immediate repercussions with respect to the international steel cartel, and it is surprising, in view of the recent fiscal history of this country, that the other countries concerned in the cartel acted as if the tariff increase was unlikely. There is no need here to summarise the White Paper giving the reasons for the decision reached by the Import Duties Advisory Committee. The new duties have been welcomed by the British Iron and Steel Federation, and the reorganisation of the industry will continue.

The annual dinner was one of the most impressive functions of its kind we have ever attended, and something like a thousand people heard the Prince propose the principal toast. Reviewing the advances that had been made in the metallurgy and production of steel for use on land, on sea and in the air, he attributed these advances to research and deplored the false economy of firms closing down laboratories and research departments. He touched a very true note in suggesting that competition among ourselves was all very well when we had a world monopoly, but that present conditions necessitated co-operation among ourselves so that we might achieve practicable understanding with foreign competitors. The acclamation with which the various points were greeted suggests that the iron and steel industry as a whole is in sympathy with them. Conversely, the grant of such a high tariff rate places responsibilities on the industry with respect to the consumer, which we have no doubt will be adequately borne. Altogether, the portents for the industry and its future are bright, and that section of the foundry trade bound up with the iron and steel industry has a promising future also. All foundries are more or less affected by the stabilisation of this great industry in its attempt to cater for the home market. The presence of so many large consumers at the dinner perhaps indicated that they also appreciated this point.

The Foundry Exhibition

It is twenty-two years since Mr. F. W. Bridges organised the first foundry exhibition at the Agricultural Hall. In recent years this has become the regular venue for foundrymen, but this year it has been decided that inasmuch as interest in foundry plant has spread to the mechanical engineer and metallurgist, the foundry industry would be well advised to associate their foundry exhibition with the Shipping, Engineering and Machinery Exhibition, to be held from September 17 to 28 at Olympia. There is undoubtedly a *cachet* associated with this building which is unrivalled anywhere in Europe. The developments recently effected in foundry practice and in its equipment and the nature of its supplies will be inspected by a much greater number of people than obtained at the Agricultural Hall. The losing of the Foundry Exhibition as a means of portraying the industry as an economic whole is to be deplored on sentimental grounds only. With the advent of the tariffs it had already lost much of its international character and a perusal of the list of exhibitors will reveal that the major portion of the plant and material shown will be of British manufacture.

The exhibition is assured of the very close co-operation of both the Institute of British Foundrymen and the British Cast Iron Research Association, and these two bodies can be relied upon to impress upon the engineering fraternity the enhanced properties of castings made under properly controlled conditions. This alone should help to arrest some of the insensate competition now being made by plastics and weldings.

The period of the exhibition is particularly fortuitous, as it will enable provincial foundrymen, who propose participating in the International Foundry Congress to be held at Brussels, to inspect the exhibition during their passage through London. Most of the space of the foundry sections has already been assigned, and late applicants will probably have to be content with positions elsewhere in the hall. As can well be imagined it is best for the foundry industry to have the best of the exhibits concentrated in the same area, in order to stress its importance in relation to general engineering.

XUM

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Sand-blasting Problems

To the Editor of The Foundry Trade Journal.

Sir,—In my letter published in your issue of March 21, you have inadvertently omitted the table giving relative efficiencies of various abrasives, illustrating the comments in paragraph (2). This table reads:—

Abrasive.	Relative efficiency, Direct impact.
New steel grit, 30's	100
New steel grit, 50's	92
New flint grit, 12's	91
Used flint grit, 12's	90
Mixed new steel grit—	
One-third each, 12's, 24's and 30's	90
Old steel grit, originally 30's ..	62
New steel grit, 12's	59

F. W. Neville.

Vulcan Works,
Blackfriars Road,
Manchester.
March 25, 1935

Sand Blasting

To the Editor of The Foundry Trade Journal.

Sir,—Having read Mr. Kenneth Hill's reply to my criticism of his article on sand blasting, it occurs to me that he has still missed the point that prompted my intrusion. For it is futile to argue that a Paper teeming with generalisations such as was published in your issue of January 17 was written for the benefit of vitreous enamellers alone. Why, the third introductory paragraph discusses the various applications of sand blasting, and the cleaning of castings has precedence in that list.

It is noted that Mr. Hill admits "revisionary errors" in his grouping of pressure-work-done ratios, but that is not enough. He has not withdrawn his unequivocal and, to my mind, mischievous statement that, if the air pressure is doubled, the work done will be doubled, too. Once again I challenge that statement.

As I wrote in your issue of January 31, the most economical pressure is that necessary for the abrasive to penetrate through the extraneous matter, and, that pressure having been produced, the work done will depend on the bore rather than the pressure. Mr. Hill chooses to ignore that significant word "rather," just as he does the reservation that in the case of vitreous enamelling the above rule does not apply on account of the necessity of cutting a key, but proceeds to the obvious assertion that work done depends on both bore and pressure. But the issue is still evaded, because we are seeking the economical pressure, which is that just calculated to do its job—and no more.

This, then, is the issue: Is the effective area of impact doubled if the pressure is doubled? For my part, I say most emphatically it is not. Assuming the pressure is adequate to its task, then doubling that pressure will not double the effective area of impact, which, after all, is the decisive factor. I put it to Mr. Hill that 20 per cent. increase in the effective area of impact would be a generous allowance; surely he will not suggest that a 100 per cent. increase in compression will increase the compressor costs by only 20 per cent.? No, the only practical method of increasing the work done is to increase the bore and/or number of nozzles.

But perhaps Mr. Hill, unlike the majority of us, does not concern himself with costs. Otherwise we might have the concession that rotary tables with mechanically-operated nozzles are ex-

(Concluded at foot of next column.)

pensive pieces of mechanism to maintain. If costs really count (and they do with most of us), they should be carefully considered before transmuting ideas or theories into statements of fact.—Yours, etc.,

C. J. Nurcombe
(Managing Director,
H. G. Sommerfield, Limited).

March 25, 1935.

The Qualcast Dinner

Mr. Roy Stubbs, President, and three Past-Presidents of the Institute of British Foundrymen, Mr. John Cameron, J.P., Mr. Victor Stobie, M.I.E.E., and Mr. V. C. Faulkner, were amongst the guests at the annual dinner of the Qualcast Company, of Derby, over which Mr. J. E. V. Jobson presided. The company numbered well over 600. As is usual, a number of long-service clocks were presented to employees of over 10 years' service.

In proposing the toast of "The Employees," Mr. Jobson promised a day's holiday with pay in order that the workpeople may properly enjoy the Jubilee celebrations. The works had had a record year with regard to both output and profits, and it was his policy to share such prosperity as came their way with the employees. Mr. C. Bigg, replying to the toast of "Qualcast," expressed his indebtedness to the employees for the way they had supported the management.

Catalogues Received

Cylinder Liners. Messrs. James & Company (Birmingham), Limited, of Manor Lane, Halesowen, have prepared a 20-page brochure which illustrates and describes the manufacture of cylinder liners by the centrifugal process. Once more we reiterate our rooted objection to the printing of photomicrographs on coloured paper. The brochure makes very interesting reading and discloses methods of control worthy of emulation by the non-specialised section of the industry. There is more than the usual quantity of technical information in the brochure, and a historic note is a claim that the author (Mr. G. Williams) was the first to lecture in England on the subject of centrifugal casting in 1920 to the Coventry Branch of the Institute of British Foundrymen.

Forgings. A leaflet received from Messrs. Gossell & Son, Limited, of 110, Cannon Street, London, E.C., carries a picture of a 15,000-ton forging press dealing with a 150-ton ingot which is to form a hollow-forged high-pressure vessel. This press is probably the most modern of its type and size in Europe, and is used, where warranted, for the manufacture of forgings made from high-quality alloy steel sold in Great Britain through Gossell & Son, Limited.

Company Meeting

Bairds & Dalmellington, Limited

Presiding at the annual meeting of Messrs. Bairds & Dalmellington, Limited, Mr. Robert L. Angus (chairman) criticised last year's amendments of the central and district schemes under the 1930 Coal Mines Act. He said that the Board were of opinion that the increased interference which these amendments carried in their train were not in the real interests of the nation or the business. The increased rigidity and lack of elasticity involved in the separation of quotas were already being found to raise great difficulties and to curb and hamper the natural development of their business and the company's ability to meet the changing conditions of trade and demand.

Random Shots

Japanese—But it's Greek to Marksman.

鑄鐵の軟化

P 5%以上では硬化作用が非常に大きいから，湯足は小さくとも切削性の大なるを欲するものには P を 5 %以下に下げる必要がある．炭素は最低 3.5% に止む可きである．珪素は常に 3 %を增加してはいけない．滿俺は硫黄よりも硬化作用が大きい．合組織が既に灰銑であるものを燒鈍に依つて更に柔軟性及び切削性を最大にする場合には渡來土，三元共晶燐化物等を完全に分解する事が必要である．燒鈍に依つて鑄造應力を除去する爲には 400°C 位に 6～8時間加熱して爐中冷却を行へばよい．然し燒鈍によつて抗張力は約30%まで減少することを忘れてはならない．

(*Fou. Tra. Jou.*, Aug. 30, 1934, p. 137)

* * *

The Foundry Trade Journal has a world-wide circulation. Abstracts from it appear regularly in the metallurgical journals of France, Germany, America, Russia, Belgium, and many other countries. With immense labour and much thumbing of dictionaries, "Marksman" has read appreciations of the Journal in some unbelievably difficult languages. This week, however, he was stumped, absolutely and completely.

* * *

The current issue of "Agne," the Japanese Journal of Metals, acknowledges to the Foundry Trade Journal a paragraph which defies even the most brilliant linguists among us. A prize is offered to anyone (except Mr. L. W. Bolton) who can tell us exactly what the paragraph reproduced at the top of this column is all about. It looks impressive, and even awesome, like one of the more complicated curses in "Tristram Shandy." "Marksman," with a twinge of envy, is looking forward to the day when "Agne" will forsake Mr. Bolton and print a column of Random Shots. By the way, the curious name, "Agne," owes its origin to the initials of four great Europeans, apparently much reverenced by the Japanese—Aristotle, Galileo, Newton and Einstein.

* * *

Bo'ness Iron Foundry, the second oldest in Scotland, has been bought as a site for house building by the Bo'ness Town Council. When interviewed recently, Mr. Allan White, who for more than twenty years has been foundry manager and moulder, foreman and furnaceman, electrician and engineer, had some interesting things to say. "The patterns in stock at the foundry contain the stuff of history," said Mr. White. "Here you can read of the rise of the coal industry and the decline of agriculture. The coming of the age of steam is announced by the patterns for railway chairs. There is also a grim reminder of the days of Burke and Hare. In the early part of the nineteenth century when they were robbing the graves of their dead and selling the corpses to Edinburgh surgeons, mort-safe associations for protecting the dead were formed in many parts of Scotland. The Bo'ness Foundry manufactured most of these mort safes, which were strong iron cages covering the coffins. At one time, Bo'ness ploughs were known throughout the world. Scottish farmers in the Colonies sent to Bo'ness whenever they needed a plough or a harrow. The implements were taken to pieces, numbered in sections, shipped abroad and reconstructed there."

* * *

There may be many interesting old patterns lingering in stock in various foundries throughout the country. "Marksman" would be glad to hear of any such curiosities.

Marksman.

XUM

Free and Hindered Contraction of Cast Carbon Steel*

By CHARLES W. BRIGGS† and ROY A. GEZELIUS,† Washington, U.S.A.

A study of the contraction taking place in the cooling of steel castings from the solidifying temperature of the steel to room temperature, involves not only the consideration of the character of free contraction but that of hindered contraction as well. A thorough investigation of the free contraction of a steel casting does not necessarily portray the actual conditions encountered in the contraction of a commercial steel casting.

In the first report of this series, evidence was advanced which summed up the previous work on the contraction of cast steel. It was pointed out that Körber and Schitzkowski studied the contraction of cast steel employing apparatus similar to that used by Wust and Schitzkowski in their study on the contraction of cast iron. From their experimentation, Körber and Schitzkowski concluded:—(1) The contraction characteristics of acid and basic steel were the same; (2) the contraction was independent of the diameter of the bars; (3) approximately one-half of the total free contraction occurred before the bars passed through the critical range; (4) the total free linear contraction was about 2.18 per cent.; (5) the hindered contraction was dependent on the nature of the mould resistance.

Although this work was admirably accomplished, there were several points that needed further study. These may be enumerated as follows:—(1) Is the carbon content of cast steel responsible for variations in the free and hindered contraction?; (2) what is the nature of the loads that exist as compared to the amounts of hindered contraction?; and (3) would one-half of the total free contraction occur before the critical point if the critical points were made more pronounced?

From the data on hand it seemed possible that the carbon content of cast steel would be responsible for variations in the linear contraction, since many investigators have shown by their studies of the specific volume of steel from 20 to 1,000 deg. C. that the specific volume is, among other things, dependent on the carbon content. This condition was also found to be true by Benedicks, Ericsson and Ericson from their results obtained in studying the specific volume of steel in the liquid state. Since the specific volume varies inversely with the contraction, it would logically appear that the carbon content would influence the amount of linear contraction. This condition, however, was not recorded by Körber and Schitzkowski, even though they used cast steels varying from 0.15 to 0.50 per cent. carbon in their experiments.

There has long been a need for a quantitative study of hindered contraction, for it is this type of contraction that is usually involved in commercial practice. Gaggers, sand conditions, casting design and moulding-box construction are all factors to be considered in fixing responsibility for hindered contraction. It thus appears advantageous to study the loads that exist on the casting during the action of hindered contraction.

In order that test conditions would be similar to the conditions found in the production of a steel casting, studies on the contraction of cast steel were carried out on the cooling of a casting from the solidifying temperature to room temperature. Previous investigators have studied the cooling of liquid metal to room temperature. They used bars of a uniform diameter, and, as was pointed out, the bars did not cool at a uniform rate, and thus the critical points were not pronounced. Conclusions as to the relative amounts of contraction before and after the critical point become much more accurate if the critical points are more pronounced. Thus, a bar that has a uniform cooling rate is more suitable for use in obtaining contraction data.

Test Methods

The procedure used in collecting the data on the free and hindered contraction of cast steels with various carbon contents is given in the following paragraphs.

Bar Design.—A bar design was developed with large ends and a small central section fed by a horn gate, as it was deemed necessary that the bar should cool uniformly along its axis. This design is shown in Fig. 1. A bar of this type was desired because then all portions of the bar would pass through the critical range at about the same time, and the data obtained would be more accurate than that obtained on a straight bar where portions of the bar are contracting and other portions are expanding at the same time.

The bar is 30 in. long, with a diameter at the centre of $1\frac{9}{16}$ in. (a cross-sectional area of 2 sq. in.) and a diameter at the ends of $2\frac{1}{4}$ in. At each end of the bar is a section $1\frac{3}{4}$ in. in dia. and 2 in. long. This section acts as a clamp on the stainless-steel bolt, and, of course, does not cool at the same rate as the remainder of the bar, because of the chilling action of the bolt. This chilling effect does not extend much beyond the $1\frac{3}{4}$-in. dia. section, as a thermocouple placed on the axis of the bar at a distance of $\frac{1}{2}$ in. from the end of the bolt recorded the same temperature that was obtained by other thermocouples at other points on the axis.

Type of Sand.—The sand used is a synthetic green sand, using No. 40 washed silica sand as a base and mixed in the following proportions by volume:—500 parts silica sand, 19 parts bentonite, 1 part Mogul binder, and 5 per cent. (by weight) water. The mixture is mulled for five minutes and the following properties are obtained:—Permeability, 180 c.c. per min.; compression strength, 3.5 lbs. per sq. in.; shear strength, nil; tensile strength, nil. The sand is reclaimed after it has been used. The properties of the reclaimed sand are the same as those of a newly-prepared sand.

Moulding Procedure.—Steel flasks constructed of 5-in. channel iron, 36 in. long, and 10 in. wide, are used as the mould containers. The sand is rammed lightly to a mould hardness number of about 50. A horn gate, varying from 2 in. to $\frac{3}{4}$ in. in diameter, is used for the pouring gate. The $\frac{3}{4}$-in. section, where the steel enters the mould cavity, is much smaller than the contraction bar at this point, and hence freezes before the bar, thus allowing very little feeding during the solidification of the bar.

A relieving block $1\frac{1}{2}$ in. square, shaped similarly to the horn gate, is moulded-in a short distance away from the horn gate. This block is removed from the mould, and when the hindered bars contract the horn gate is able to move freely without being restricted by the moulding sand. The surface of the mould cavity is not covered with a mould wash.

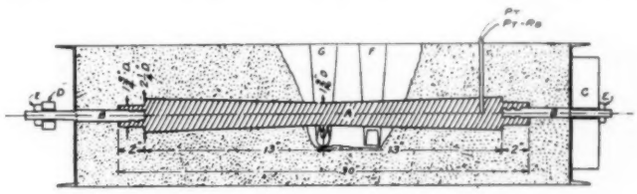
Assembling the Mould.—The mould ready for assembly carries a stainless steel bolt protruding from each end of the moulding box. One bolt ties the bar down to the moulding box, and the other is fastened to the flat steel spring. The bolts are $\frac{7}{8}$ in. in diameter and have a 4-in. shank and a 5-in. body. Two grooves $\frac{3}{8}$ in. wide and $\frac{1}{8}$ in. deep are machined in the body end of the bolt. This permits the metal, upon solidifying around the bolts, to have a strong grip on them. The chilling action is so great that the bolts do not fuse into the cast metal.

A small quartz thermocouple protecting tube is run through the cope of the mould $1\frac{1}{2}$ in. from the end of the bolt that ties the cast bar down to the flask. This tube extends to the axis of the bar, and the readings obtained by the platinum-platinum-rhodium thermocouple represent the temperature of the bar throughout the central 26 in.

The flat springs used were made out of 2-in. by $10\frac{1}{2}$-in. heat-treated spring steel and are of the following thicknesses:—

"*C*" springs $\frac{7}{8}$ in. thick.
"*G*" " $\frac{9}{16}$ " "
"*E*" " $\frac{3}{4}$ " "

Ames dials, held by an arm bolted to the end of the boxes are used for measuring the amount of contraction. A moving-picture camera using a 16-mm. film operated by a Telechron synchronous motor records the amount of shrinkage and the temperature every 15 sec. The temperature recorder is a pyro-millivoltmeter and has a temperature range of 0 to 1,600 deg. C. The Ames dials are graduated to 0.001 of an inch.



A—Cast bar. B—Stainless steel bolts. C—Steel block. D—Steel spring. E.—Nuts. F.—Relieving block. G—Horn gate.

Fig. 1.—Design of Contraction Bar.

It was found that to show the true free contraction, the bar must be free at both ends and that two Ames dials were required. The true contraction was not recorded if one end of the bar was tied down and measurements were taken with only one end contracting freely. The runner box, which is used for convenience during pouring, is slotted at the base so that the excess metal will run out and not act as a feeding head or restrict contraction.

Type of Steel

The steel is made in a 500-lbs. per hr. Swindell, 3-phase, electric-arc furnace. The basic practice has been used entirely during the collecting of the data presented in this report. An attempt has been made to use steels, the compositions of which are comparable to those found in the foundry industry. However, to complete the data, steels with lower and higher carbon contents than those generally used in the industry have been investigated. In all cases conditions as to chemical analysis and steelmaking have been duplicated as nearly as possible several times so that the data obtained could be checked carefully.

Pouring

The steel is poured from a tea-pot ladle so that slag has very little opportunity to

* A Paper read before the Annual Meeting of the American Foundrymen's Association.

† Division of Physical Metallurgy, U.S. Naval Research Laboratory, Washington, D.C., U.S.A.

enter the mould. The pouring temperature of the steel entering the moulds is between 1,582 and 1,538 deg. C. Aluminium is added to the ladle in amounts equivalent to 500 grams per ton, prior to pouring.

Practical Features

The amounts of total contraction obtained on the freely-contracting bars are considerably higher than any previously recorded. The data obtained indicate that the contraction varies from 2.47 per cent. for a 0.08 carbon steel to 2.18 per cent. for a 0.90 per cent. carbon steel. These results, of course, have little practical application, for few commercial castings are able to contract freely.

The data obtained with the lightest "E" spring probably represent more closely the stresses encountered by the average commercial casting, as the total contraction recorded under this tension approximates the "patternmaker's shrinkage" of $\frac{3}{8}$ in. per foot (1.56 per cent.). The contraction recorded, using this spring, varied from 1.56 per cent. with a 0.08 per cent. carbon steel to 1.79 per cent. with a 0.90 per cent. carbon steel.

The data recorded with the medium "G" spring probably approximates conditions existing in castings which, due to design or to unusually high mould resistance, are unable to contract a great deal.

The tensions exerted by the strong "C" spring are probably greater than any encountered in commercial practice, but the data are included to indicate how these unusually high stresses would effect contraction. It should be noted that, with these very high stresses, the carbon content does not effect the amount of total contraction to any great extent. The amount of total contraction is very low for all carbon contents, being only 0.46 to 0.52 per cent.

An interesting point that is of great practical importance is brought out by the data obtained on the hindered contracting bars. In the case of the light "E" spring, where conditions are similar to actual casting conditions, it will be noted that at 1,300 deg. C., the temperature range most susceptible to cracking, the 0.08 per cent. carbon bar has contracted 0.18 per cent. and has developed a stress of 425 lbs. per sq. in. on its smallest section, whereas the 0.90 per cent. carbon steel has only contracted 0.002 per cent., with a corresponding stress of about 50 lbs. per sq. in. When the 0.90 per cent. carbon steel has contracted to the 0.18 per cent. value exhibited by the 0.08 per cent. carbon steel at 1,300 deg. C., the temperature is 1,090 deg. C.

This effect is even more noticeable in the cases of the bars restrained by the strong "C" spring. In this case, the 0.14 per cent. carbon steel at 1,300 deg. C. has contracted 0.006 per cent., which results in a stress of 1,200 lbs. per sq. in. At the same temperature, the 0.35 per cent. carbon steel has only contracted 0.003 per cent., and thus has to resist only a stress of 600 lbs. per sq. in. The 0.35 per cent. carbon steel cools to a temperature of 1,070 deg. C. before it has to resist the same tension as the 0.14 per cent. carbon steel does at 1,300 deg. C.

There has been considerable discussion as to the relative strengths of cast steels at temperatures near the melting point. These data point out the fact that the rate of contraction as well as the strength of the steel may influence the formation of hot tears in steel castings. The examples given previously show that, if the strengths of the 0.14 and 0.35 per cent. carbon steels were identical at a given temperature, the danger of the formation of hot tears would be greater in the 0.14 carbon steel as the rate of contraction, and therefore the rate of stress increase is greater. These relative rates of contraction apply under all conditions of hindered contraction down to the critical range.

One practical use of data of this type is the determination of the amount of stress that any particular casting has withstood. It should be possible, by measuring the completed casting and the pattern, to determine the amount of contraction and from this the tension the casting has encountered.

Summary

The authors offer the following summary as a conclusion to this Paper:—

(1) The total amount of free contraction of cast carbon steel decreases as the carbon content of the steel increases. The contraction varies from 2.47 per cent. for 0.08 carbon steel to 2.18 per cent. for 0.90 carbon steel.

(2) The amounts of contraction of the freely contracting bar, taking place prior to reaching the critical range, decrease as the carbon content of the steel increases.

(3) The amounts of contraction obtained after the freely-contracting bars have passed through the critical range are approximately equal.

(4) In the case of the freely-contracting and the lightly-hindered-contracting bars, the carbon content influences the rate of contraction markedly until the bars have contracted approximately 0.10 per cent.

(5) Hindered bars contract similarly to the freely-contracting bars in that, at any temperature prior to the critical range, the amount of contraction is greater with decreasing carbon contents.

(6) The total amounts of hindered contraction increase as the carbon content increases.

(7) The percentage of the total contraction occurring before the critical range is reached decreases as the tension restraining the bar increases.

(8) The hindered-contraction data, obtained with the lightest spring, represent approximately the stresses encountered by the average commercial casting as the total contraction under this tension approximates the "patternmaker's shrinkage" of $\frac{3}{16}$ in. per ft.

(9) Slight variations from the normal manganese or silicon content of cast-carbon steel do not result in measurable differences in the rate or total amount of free or hindered contraction.

(10) The rate of contraction, as well as the strength of the steel, may influence the formation of hot tears in steel castings.

(11) The contraction taking place upon the solidification of cast steel, as approximated from the present available data, is 2.7 per cent.

Acknowledgment

The authors wish to thank various members of the Naval Research Laboratory for their ready co-operation in the research problem; Dr. R. H. Canfield, for his good counsel and valuable criticisms; Mr. James Darby and Mr. Roy Donaldson for their aid in the test procedures, and Mr. Louis Singer for chemical analysis.

Metal Treatment

NEW TECHNICAL JOURNAL

At the end of this month the first issue of a new technical journal entitled "Metal Treatment" will be published by the proprietors of the Foundry Trade Journal. This new publication is designed to fill a long-felt want in providing a review of current practice in the treatment, machining and use of modern steels and alloys (ferrous and non-ferrous). The editorial will embrace every phase of interest to both the producer and user. Some of the principal articles in the first issue will include:—

"Factors Affecting the Capacity and Thermal Efficiency of Furnaces," by Herbert Southern, A.M.I.Mech.E., etc.
"Present and Future Progress in Bronze Founding," by Francis W. Rowe, B.Sc., etc.
"New Alloys for Magnets," by Dr. A. B. Everest.
"Use of Ferrous Metals for Aeronautical Purposes," by J. R. Handforth, M.Sc.
"Intercrystalline Corrosion Phenomenon as Observed in Certain Chromium-Nickel Corrosion-Resisting Steels," by Dr. W. H. Hatfield.
"New Heat-Treatable Alloys Containing Nickel," by J. McNeil, A.R.T.C.
"Manufacture and Uses of Metal Powders," by J. C. Chaston, B.Sc., A.R.S.M.
"Some Aspects of Heat-Treatment," by Prof. J. H. Andrew
"Grain Size Control and Its Effect on the Mechanical Properties of Forgings," by Dr. J. M. Robertson.
"Milling Cutters," by Prof. Dr. Georg. Schlesinger.

There will also be a review of modern machine tools and an article on "The Life of Turning Tools as Affected by Shape."

"Metal Treatment" will be the most comprehensive journal of its kind and will be published quarterly at a price of 1s. (1s. 3d. post free). The annual subscription will be 5s. Orders should be sent to Industrial Newspapers, Limited, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

The annual general meeting of the Foundry Trades' Equipment & Supplies Association was held at the Northumberland Rooms, London, W.C.2, last Thursday. As the President, Mr. R. H. Brackenbury, was abroad, the chair was occupied by Mr. G. T. Lunt, who was afterwards elected President. Mr. A. C. Turner was re-elected Vice-President and Mr. G. E. France was also elected to that office. Mr. K. W. Bridges announced that the following firms had taken space in the forthcoming Foundry Trades' Exhibition to be held in conjunction with the Shipping Engineering and Machinery Exhibition at Olympia from September 12 to 28 this year:—

Atlas Preservative Company, Limited; Baird, William & Company, Limited; Bradley & Foster, Limited; British Pigirons, Limited; Colvilles, Limited; Electromagnets, Limited; Fordath Engineering Company, Limited, The; Foundry Trade Journal; Imperial Chemical Industries, Limited; Morgan Crucible Company, Limited; Parish, J., & Co.; Spermolin, Limited; Sterling Foundry Specialties, Limited; Stewarts and Lloyds, Limited; Ward, Thos. W., Limited; Armstrong, Whitworth, Sir W. G., & Company (Ironfounders), Limited; Cassier, Louis, Company, Limited; Consolidated Pneumatic Tool Company, Limited; General Refractories, Limited; Wilkinson, Thomas, & Company, Limited; Rapid Magnetting Machine Company, Limited; Hearson, Chas., & Company, Limited; Gledhill-Brook Time Recorders, Limited; Wm. Cumming & Company, Limited; August's, Limited.

Space is rapidly being taken up, and those firms which have not yet made reservation should write to Messrs. F. W. Bridges & Sons, Limited, Grand Buildings, Trafalgar Square, London, W.C.2.

Publication Received

A Useful Chart. A wall chart has been evolved by Foundry Services, Limited, of 285, Long Acre, Nechells, Birmingham, 7, which sets out in a very intelligent manner the influence of 19 impurities on ten non-ferrous metals and alloys. We deem this to be very useful for the average brass and light-alloy foundryman, and we strongly counsel our readers to request that the publishers furnish them with a copy.

An official of the Bo'ness Iron Company, Limited, has informed our Scottish correspondent that the Bo'ness Foundry will continue to be carried on by the company. The Bo'ness Iron Company purchased the goodwill, plant and patterns of the Bo'ness Foundry on May 18, 1934, and are carrying on the business as usual along with their own.

Heat-Treated Grey-Iron Cylinder Liners*

By W. PAUL EDDY, Jr.,† Pontiac, Mich., U.S.A.

[Extract.]

Introduction

The resistance to wear of cylinder bores of heavy-duty lorry and motor-coach engines has always been an important factor in the life and economy of operation of such vehicles. Hardness and strength of cylinder irons had been continually increased, until, about three years ago, the cylinder-block castings used by the company with which the writer is associated were of an electric-furnace chromium-molybdenum iron having hardness of Brinell 229-241, tensile strength of not less than 20 tons per sq. in., and transverse strength (as measured on A.S.T.M. test-bars on 18-in. centres) of not less than 3,300 lbs.

Although this material represented approximately the hardest and strongest machinable iron available in such intricate castings as cylinder blocks, it was desired to effect still further improvement in cylinder life. The resulting investigations led to the adoption, in 1931, of hardened grey-iron cylinder liners of the dry type. Since the original adoption of this type of construction, further improvements in both material and design have naturally been made. This Paper discusses briefly the development, manufacture, properties and service performance of these cylinder liners.

Development

The amount of experimental work involved has been large. Initially, experiments were conducted with ten different grey-iron compositions, including nickel, nickel-chromium, manganese-nickel-chromium, and nickel-molybdenum, with varying amounts of alloying elements and total carbon, and with combined carbon contents from 0.50 to 1.80 per cent. as-cast. This work involved hundreds of heat-treating tests, together with analyses, strength tests, microscopic examinations and hardness tests. A large amount of experimental work in the machine shop was also found necessary in order to develop sound production methods and to minimise losses.

Requirements

The primary requirement was, of course, high hardness. It was also decided, because of the inherent fragility of large thin-walled cast-iron cylinder liners as compared with many other automotive parts, and because liners must be handled and installed by garages as well as by the author's factory, that little, if any, sacrifice in strength from that of the original castings could be tolerated. Soundness of castings was essential. Machinability was important from the standpoint of cost. Freedom from distortion during heat-treatment and ability to duplicate results consistently were also factors.

It was found that highest hardness after quenching was obtainable with a mottled iron which had previously been annealed to a commercially machinable hardness. The finely divided temper-carbon formed in annealing apparently redissolved readily upon heating for hardening, forming a high-carbon austenite which quenched to a very hard martensite. However, these types of iron had several disadvantages. First, the greater shrinkage of the low-graphite irons increased the difficulty of producing sound castings. Second, the annealing operation was difficult to control so as to obtain uniformly good machinability and consistent dimensional changes during subsequent hardening. Third, the small amount of graphite present appeared to be undesirable in a cylinder.

Low combined-carbon irons did not harden sufficiently. The best irons from every standpoint were those with slightly under 1 per cent. combined carbon; such irons could be made into sound castings, machined readily as-cast, and hardened uniformly with no appreciable change in free carbon contents.

In order to obtain iron of this type which could be cast in thin sections without chilling at edges, which would harden sufficiently by oil quenching and which would as nearly as possible fulfil the other requirements previously mentioned, the addition of approximately 0.65 per cent. chromium, with sufficient nickel to balance, was found necessary. Such an alloy iron, which is used to-day, is not claimed to be the last word in hardenable cylinder liner irons, and experiments are still being conducted in an attempt to effect further improvement or to equal present performance at lower cost.

Specifications

The complete specification for the cylinder liner iron, as in force at present, is as follows:—

Quality. — Castings shall be smooth, well cleaned, and free from shrinkage cavities, cracks, sand holes, large inclusions, chills, excess free carbides, and any other defects detrimental to machinability, appearance or performance. They shall finish to the size specified.

Composition.—T.C., 3.10 to 3.40 per cent.; C.C., 0.75 to 0.90; Si, 1.90 to 2.10; Mn, 0.55 to 0.75; S, 0.10 max.; P, 0.20 max.; Cr, 0.55 to 0.75; and Ni, 1.80 to 2.20 per cent.

Physical Properties.—Hardness, as-cast — Brinell 212-241; transverse strength (A.S.T.M. arbitration bars)—2,400 lbs. minimum; transverse deflection—0.20-0.30 in.; tensile strength (test-bar machined from castings)—16.5 tons per sq. in. minimum.

Soundness.—Cylinder liner castings, when machined to approximately $\frac{1}{8}$ in. wall thickness, shall withstand 1,500 lbs. per sq. in. hydrostatic pressure, internally applied, without leakage or failure.

Heat-treatment.—Cylinder liner castings with a wall thickness not greater than $\frac{3}{8}$ in. shall, after being heated in an oven-type furnace at 835 to 845 deg. C. for 30 to 40 min. and quenched in still oil, have a hardness of not less than Brinell 512 or Rockwell C52.

Advantages.—Adoption of cylinder liners has permitted the use of a softer and cheaper iron for the blocks, the saving in material and machining thereof partially balancing the increased cost of the liners.

Properties.—Castings actually obtained to the above specification have properties, in general, in excess of the specified minima.

Strength.—Arbitration bars show transverse strengths of 2,700 to 2,900 lbs., on 18-in. centres, whilst tensile strengths in tons per sq. in., as determined from test-bars machined from castings, are in the following order:—

	Tons per sq. in.
As-cast	16.5—18.5
Aged	17.0—19.2
Hardened	12.5—16.1
Hardened, and tempered at 149 deg. C., 2 hrs.	14.7—17.5
Hardened, and tempered at 177 deg. C., 2 hrs.	16.1—18.0
Hardened, and tempered at 232 deg. C., 1 hr.	17.5—19.2
Hardened, and tempered at 316 deg. C., 1 hr.	20.0—25.0

Strength measurements have also been made by crushing machined liners radially between two flat parallel plates. Each load is measured at occurrence of the first crack, which is clearly audible. This test is more sensitive and gives more nearly reproducible results than does the tensile test. The average results of many crushing tests were as follow:—

Aged	3,850 lb.
Hardened	2,400 lb.
Hardened, and tempered at 149 deg. C., 2 hrs.	3,000 lb.
Hardened, and tempered at 177 deg. C., 2 hrs.	3,450 lb.
Hardened, and tempered at 232 deg. C., 1 hr.	3,800 lb.
Hardened, and tempered at 316 deg. C., 1 hr.	3,950 lb.

Hardening may reduce strength from between 10 to 40 per cent., the original strength being gradually restored by progressively higher tempering. It is well known that tempering at temperatures above 316 deg. C. produces strengths higher than that as-cast, but hardnesses obtained thereby are much lower than we desire in cylinder liners. The best combination of hardness and strength seemed to be obtained by tempering at 177 deg. C. for 2 hrs.; strength is approximately 90 per cent. of that as-cast.

Hardness. — Results obtained over a long period in heat-treating cast iron are, in general, somewhat less uniform than those usually obtained in heat-treating alloy steels. Most of these cylinder liners harden satisfactorily when oil quenched from 802 to 816 deg. C., but there are some which require heating to slightly higher temperatures in order to produce maximum hardness after quenching. Variable hardening temperatures are undesirable from the standpoint of uniform distortion and growth, so that General Motors have standardised on heating in an oven furnace at 843 deg. C. for a total time of 32 min. Hardnesses of liners are quite consistently within the ranges shown in Table I.

Table I.—*Hardness of Liners.*

Treatment.	Hardness.		
	Brinell.	Vickers Brinell.	Rockwell.
As-cast and after aging	217–248	—	B 96–101
Hardened	—	570–650	C 52–57
Hardened, and tempered at 149 deg. C., 2 hrs.	—	530–610	C 50–55
Hardened, and tempered at 177 deg. C., 2 hrs.	—	500–570	C 48–52
Hardened, and tempered at 232 deg. C., 1 hr.	—	470–530	C 46–50
Hardened, and tempered at 316 deg. C., 1 hr.	—	450–500	C 44–48

Microstructure.—Typical microstructures show that the matrix of the liner before hardening consists of about equal quantities of sorbite and finely lamellar pearlite, with an appreciable quantity of free cementite in fairly well-distributed particles; with combined carbon approaching the upper specified limit, the carbide particles tend to form a coarse broken network. The hardened liner structure is finely martensitic, apparently darker and finer near each carbide particle where some cementite has been dissolved and partly diffused during heating and reprecipitated in the form of tiny spheroids on quenching. No difference between the structures as hardened and after tempering at 177 deg. C. is apparent.

Expansion.—Hardness obtained by water-quenching these liners is the same as that after oil-quenching. Following are results of a number of tests on machined liners, 4$\frac{1}{2}$-in. inside dia. and 5$\frac{1}{8}$-in. outside dia., heated in an upright position on the hearth of an oven furnace at

D

* A Paper read before the Philadelphia International Congress.
† The Author is Metallurgist to the General Motors Truck Corporation.

843 deg. C. for 35 min., and quenched in an open tank with a slow up-and-down motion:—

	Water quench.	Oil quench.
Increase in average dia. ..	0.013 to 0.018 in.	0.010 to 0.014 in.
Out-of-roundness	0.012 to 0.020 in.	0.002 to 0.006 in.

Another characteristic, which would be evident in any thin-walled cylinder liner, is worthy of note. In the original design, liners were finish-ground on outside diameters to 0.003 to 0.005 in. larger than the ground bore diameters in the blocks. Liners were assembled into blocks from the bottom, the tops of liners being nearly flush with top surfaces of blocks. A maximum load of 6,000 to 12,000 lbs. was required to press a liner into position.

Although this amount of press-fit was ample, the press-fit was found to decrease gradually during operation of the engine. As the liners naturally become hotter than the surrounding metal of the block, the radially compressive stresses on the liners increase until the elastic limit at the operating temperatures is exceeded, when the liners suffer slight permanent contraction. Although the diameters of liners in cylinder blocks are unchanged, their "free" diameters have been decreased, and the amounts of press-fit have been proportionately lessened. This action may, in extreme cases, proceed so far that press-fits, when cold, become low enough to permit liners to slip down slightly in the blocks. The present design, which includes a small flange at the top of the liner and a counterbore of equal size in the top of each bore in the cylinder block, and involves assembling liners into blocks from the top, eliminates the possibility of displacement of liners in operation.

Manufacture

Liner castings are made by Frank Foundries Corporation, who for many years furnished sleeve castings for sleeve-valve engines formerly made by the General Motors Company. The mould is made in a special three-part flask, the liner being cast in a vertical position with the flanged end up (in the same position as that of the finished liner in the engine), and with a tangential gate at the bottom end, the body of the casting being free from parting line and gate. A special air-jolt, air-strip moulding machine having 12-in. draw is used to make the centre portion of the three-part mould. An unusually large feed-head is required. Cupola-melted cylinder iron is used, the necessary alloy additions being made in the ladle. The lugs on the upper end are for driving in the rough-machining operations; only one lug is used, but each casting is made with two lugs, as a lug is occasionally broken off during shipment or during machining.

Service Performance

Cylinder liners are used in the four largest engines General Motors build—Types 468, 525, 616 and 707, the type numbers being the respective displacements in cubic inches. All are six-cylinder, valve-in-head engines, having heat-treated aluminium-alloy pistons and cast-iron piston rings of Rockwell B 100 to 106 hardness. These engines are used in large coaches and lorries, the majority in the former. New engines are run under load on dynamometers for 12 to 16 hrs. before assembling into vehicles. With the one-piece cylinder blocks formerly used, having hardness of Brinell 229 to 241, the present blocks with hardened liners may be contrasted on several points.

With the old blocks, running equivalent to 400 to 600 miles was required to break-in the rings and cylinder walls; the breaking-in was therefore complete at the end of the dynamometer run. The new engines require 3,500 to 5,000 miles completely run-in the rings, as the cylinder walls do not wear appreciably, although the engines can be operated on regular schedule as soon as purchased, without harmful effects. The longer run-in period means that oil consumption is usually high at first, gradually dropping off to a satisfactory low figure as running-in is completed. The average consumption of the largest engine (the 707) is 50 to 60 miles per quart at first, and 200 to 250 miles per quart after running in. Thereafter, consumption remains constant for a considerable period, then gradually increases as the engine parts wear; both old and new type cylinders are usually reconditioned by operators when mileage of less than 50 per quart is attained.

The old blocks were usually reworked by honing to 0.010 in. oversize and installing 0.010-in. oversize pistons and rings. Blocks could be reconditioned in this manner until 0.030 in. oversize (although some operators rehoned a fourth time to 0.040 in. oversize), after which blocks were scrapped.

The blocks with liners are usually reworked by grinding (they can be honed but this is rather tedious) to 0.010 in. oversize and installing oversize pistons and rings. Liners can be reground as many times as could the old cylinder blocks, after which the blocks are not scrapped but are refitted with new liners.

The life of a cylinder block between reconditionings varies considerably, depending on operating conditions and maintenance practices. The type of operation (city or cross-country), type of roads, speeds, lubrication policies, kind of fuel, corrosive conditions in combustion chambers, and maintenance of efficiencies of air cleaners, oil filters, oil coolers and engine-cooling systems are some of the factors that influence engine life.

In spite of these variables, records provide fairly definite data. The old-style cylinder, under such varying conditions, ran 25,000 to 75,000 miles between reconditionings. The new cylinders, although operating in general on faster schedules, run 75,000 to 200,000 miles between reconditionings; furthermore, in many operations which are more severe, it is merely necessary, after 75,000 to 125,000 miles, to install new standard-size piston rings, the engine then being run 50,000 to 75,000 miles further before cylinder grinding and oversize pistons and rings are required. Tests on many liners after long service have shown that no measurable decrease in hardness occurs during operation.

The operating costs of our engines have obviously been materially reduced by the use of hardened inserted cylinder liners. This is more readily appreciated when it is remembered that a total mileage of a coach in excess of 500,000 is not at all uncommon. The new engine not only requires but one-third as many cylinder reconditionings than the old, but also uses the same cylinder block throughout its life.

Acknowledgments

The author wishes to express his appreciation to the management and engineering executives of General Motors Truck Corporation for their support and encouragement, and to acknowledge gratefully the assistance of several persons in the preparation of certain portions of the Paper, especially Mr. A. W. Zimmer (manufacturing methods), Mr. L. T. Flynn (service performance) and Mr. W. H. Sanderson (illustrations and photomicrographs).

---

(10) "An Effect of Oxygen and Sulphur on Iron in Scaling," by J. H. Whiteley.

The following communications have been received and will be printed in the Journal:—"A Note on Reproducible Sulphur Prints," by W. H. Dearden; "Electro-Chemical Interpretation of 'Cleaning,'" by E. Jimeno and I. Grifoll.

Autumn Meeting

The Autumn Meeting will be held in Manchester and District on September 16 to 18, 1935.

Iron and Steel Institute

PROGRAMME OF ANNUAL MEETING

The annual meeting of the Institute will be held, by kind permission, at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Wednesday, Thursday and Friday, May 1, 2 and 3. The last two days will be devoted to a Symposium on the Welding of Iron and Steel, organised by the Institute in conjunction with other Technical Societies (see last week's Review).

Wednesday, May 1.

The general meeting will be opened at 10 a.m., when the annual report and statement of accounts for 1934 will be presented. Other business will include election of new members, induction of newly-elected President, Sir Harold Carpenter, Ph.D., F.R.S., into the chair, and the presentation of the Bessemer medal to Prof. A. M. Portevin. The President will then deliver his Presidential Address. The following Papers will be presented for discussion:—(1) and (5). At 2.30 p.m. the afternoon session will begin when the following Papers will be presented for discussion:—(10) (2) (3) (7) (9). The remaining Papers will be taken as read, but written contributions to the discussion are invited.

Thursday, May 2, and Friday, May 3.

As already indicated, a Symposium on the Welding of Iron and Steel will be held on Thursday and Friday, May 2 and 3, 1935, in the Lecture Hall of the Institution of Civil Engineers, Great George Street, Westminster. This Symposium will form part of the Proceedings of the Annual General Meeting of the Institute.

Annual Dinner

The annual dinner will be held in the Grand Hall of the Connaught Rooms, Great Queen Street, W.C., on Thursday, May 2, at 7 for 7.30 p.m. Applications for tickets (price 15s. each, exclusive of wine) should be sent in not later than Thursday, April 25.

Discussion of Papers.

Members are reminded that they are invited to take part in the verbal and written discussion of Papers. The contributions to discussions at the meetings should be spoken and not read. Those who wish to contribute by correspondence should send in their communications by May 15.

List of Papers

The following is a complete list of the Papers offered for the May Meeting, 1935:—

(1) "Third Report of the Corrosion Committee."—Being a Report of a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council. (Special Report No. 8. Copies will be supplied only on request. The report will not be reprinted after the Meeting.)

(2) "An Investigation of Spring Steels," by J. H. Andrew and G. T. Richardson.

(3) "The Deflection of the Rolls in Plate, Sheet and Strip Mills," by J. Selwyn Caswell.

(4) "Resistance of Spring Steels to Repeated Impact Stresses," by G. A. Hankins and H. R. Mills.

(5) "Further Determinations of the External Heat Loss of Blast Furnaces," by D. F. Marshall.

(6) "Non-Metallic Inclusions in Ferro-Alloys," by B. Matuschka.

(7) "The Iodine Method for the Determination of Oxides in Steel," by T. E. Rooney and A. G. Stapleton.

(8) "Transformations in Iron-Aluminium Alloys," by C. Sykes and H. Evans.

(9) "An Investigation into the Oxidising Power of Basic Slags," by J. White, R. Graham and R. Hay.

(*Concluded in previous column.*)

Recent Advances in the Founding of Aluminium Alloys

By I. G. SLATER, M.Sc., Ph.D.

(*Concluded from page* 203)

Effect of the Quality of the Ingot Metal Used

In the consideration of the quality of the ingot metals used, especially as regards initial gas content, it is a matter of frequent experience in the foundry that the incidence of pinholes in castings made from various batches of virgin aluminium ingot and of ingot alloys is very variable. Incidental factors relating to this occurrence can include variables in melting and casting practice or in the quality of the ingot metals. Occasional marked differences which are observed suggest that a further factor may be involved, derived from some conditions which may take place on storage.

In some experiments carried out at Birmingham University for the British Non-Ferrous Metals Research Association, Prof. Hanson and the author[10] have shown that both aluminium and its principal alloys can deteriorate very seriously under suitable conditions of exposure to corrosive environments such as atmospheric moisture. Experiments were made in which 3-lb. notched-bar ingots of various aluminium alloys cast from sound metal were exposed to various corrosive environments, and after exposure were remelted in an electric furnace and sand-cast. Density determinations supplemented by visual examination of pinholes on a polished half-section of the ingot indicated the amount of deterioration which had occurred in each instance. Some typical results obtained are given in Table VI.

The appearances of some of the test ingots produced, showing the extent of the pinholes present, are illustrated in Fig. 3. Good storage, as indicated in Table VI, was in a well-ventilated room where the temperature remained practically constant and the humidity rarely fell below dewpoint. Ordinary storage was on a concrete floor at ground level in an annexe to a large building where dew deposition was occasionally liable overnight. In this respect it approximated to good ordinary factory or warehouse storage. For the outdoors exposure, ingots were suspended on a wooden frame about 3 ft. from the grass, where they were subjected to all-weather conditions, including dew deposition, rain, etc.

The extent and amount of unsoundness resulting depends on the type and time of exposure and also on the alloy examined. "Y" alloy and the 12 per cent. Si-Al alloy appear to be more sensitive to these conditions than "2L5" and "3L11" alloys. Tensile test-pieces machined to B.S.I. standards of 0.564 in. dia. by 2 in. gauge length were also exposed outdoors for three months, when a deterioration in the tensile properties of sand- and chill-cast bars was found, particularly as regards percentage elongation.

When aluminium corrodes, the corrosion product so formed contains aluminium hydroxide. This hydroxide is but slowly transformed into alumina on heating, so that on remelting corroded ingots the metal will come into contact with water molecules. Contamination of the melt by hydrogen and oxide will thus occur, as previously described. In a further experiment ingots of the various alloys which had been exposed outdoors for 12 months were remelted (*a*) with the surface layer, including the corrosion product, totally removed and (*b*) with the corrosion product intact. Table VII summarises the observations recorded on the castings produced.

It would appear that, in addition to the effect due to the corrosion product, there is another effect in which hydrogen resulting from the initial corrosion reaction is absorbed by the metal and there remains until liberated on remelting.

The corrosion-deterioration effect now described is considered to be of great practical importance. It is clearly necessary that ingots of aluminium and its alloys must be stored under satisfactory conditions, particularly when stocks are held for long periods. There is no doubt that a considerable proportion of the gas in commercial aluminium ingots is introduced by exposure of the solid metal between the time it leaves the producer's furnace and the time when it is finally melted in the foundry, *i.e.*, during transport and storage. The storage of scrap similarly requires due care, a fact which more often than not is overlooked in many foundries. Miscellaneous scrap from outside sources which has been in service or exposed under injurious conditions is invariably corroded to a greater or less degree, and the use of a suitable degassing process is indispensable in order to produce relatively pinhole-free sand castings from such material.

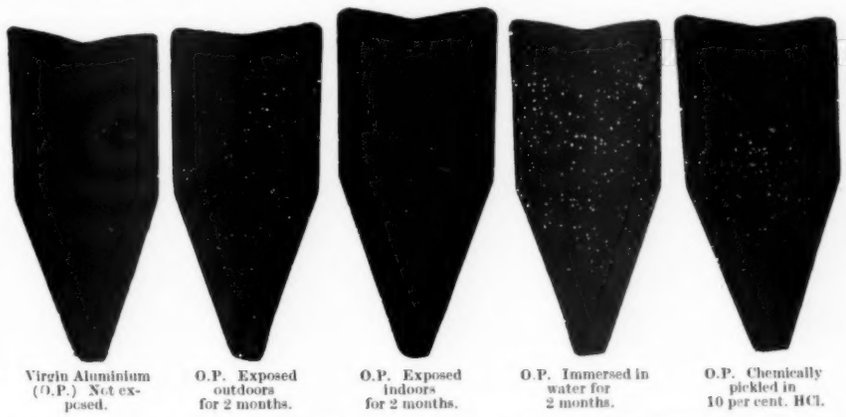

Virgin Aluminium (O.P.) Not exposed.
O.P. Exposed outdoors for 2 months.
O.P. Exposed indoors for 2 months.
O.P. Immersed in water for 2 months.
O.P. Chemically pickled in 10 per cent. HCl.

Fig. 3.—Appearance of Sections on Remelting Ingots of Virgin Aluminium after Exposure to various Corrosive Environments.

Removal of Gases from Defective Melts

Due to considerations of cost and other economic factors, the bulk of aluminium alloys cast in this country are melted in fuel-fired furnaces using oil, gas or coke in which contamination of the melt by gases is inevitable. Apart from this, large quantities of scrap are remelted, and this scrap is usually of inferior quality as regards gas content due to previous melting or by deterioration on exposure to corrosive environments during storage. In addition contamination by oil, etc., is often present with scrap and this results in a substantial pick-up of gas on melting. The practical solution of the problem is a degassing treatment of the melt just prior to casting. Various treatments which have been investigated and have received attention in practice may be summarised as follows:—

(1) *Presolidification* (*Archbutt*[11]).—By allowing aluminium melts to cool slowly, dissolved gases are evolved during solidification. On subsequent rapid remelting, sounder metal results, but some recontamination is liable. This process, which appears to be the first practical suggestion to be made for a solution of the problem, effects a considerable improvement in very gassy melts. It has been used quite extensively, but the main objections involved include loss of time during the presolidification period and the liability for recontamination on melting.

(2) *Treatment with Nitrogen* (*Archbutt and Rosenhain*[12]).—By this process, a stream of nitrogen gas is bubbled through the melt. It is important that the scavenging gas is properly dried before use. Nitrogen obtained in the usual storage cylinders is commonly contaminated with water vapour. In practice, variable results are obtained and complete degassing is not obtainable except with prolonged treatment under very favourable conditions. Often the processes 1 and 2 are used in conjunction.

Table VI.—*Influence of Exposure on Soundness.*

Exposure.	Virgin aluminium.*		3L11 alloy.		2L5 alloy.		"Y" alloy.		12 per cent. Si–Al alloy.	
	Density.	Pinholes.	Density.	Pinholes.	Density.	Pinholes.	Density.	Pinholes.	Density.	Pinholes.
None	2.807	none	2.827	none	2.969	none	2.746	none	2.656	none
Dry atmosphere, 6 months	2.807	,,	2.825	,,	2.972	,,	2.745	,,	2.655	,,
Good storage, 6 months	2.805	,,	2.827	,,	2.976	,,	2.729	few	2.644	few
Ordinary storage, 6 months	2.800	few	2.823	very few	2.960	few	2.727	mod. few	2.644	mod. few
Outdoors—Inland, 6 months	2.786	moderate	2.806	bad	2.934	bad	2.651	bad	2.629	mod. bad
Immersed in water, 3 months	2.790	,,	2.802	mod. bad	2.962	mod. few	2.728	moderate	2.609	bad
Pickled in 10 per cent. H Cl, 24 hrs.	2.795	,,	2.834	none	2.974	very few	2.734	few	2.601	moderate

* Virgin aluminium made up to 3L11 composition with degassed 50/50 Al Cu temper alloy on remelting and casting.

[10] "Journal of the Institute of Metals," 1931, **46**, 216–237.

[11] Archbutt, S. L. "Journal of the Institute of Metals," 1925, **33**, 227.

[12] Archbutt & Rosenhain. "Journal of the Institute of Metals," 1925, **33**, 227.

(3) *Treatment with Chlorine (Tullis*[12]).—Chlorine gas is used as a scavenger and is bubbled through the melt. This process appears to be more efficacious than nitrogen treatment. There are certain practical difficulties in handling the process in the average foundry, particularly due to the dangerous and toxic nature of the gas.

(4) *Treatment with Other Halogens (Hanson and Slater*[14]).—Bromine and iodine may also be used for the scavenging treatment. In addition it has been found advantageous to use a stream of nitrogen to convey the halogen into the melt. Some experimental results with small melts heated in an electric furnace using the above processes are summarised in Table VIII. For test purposes, the treated melt was cast into a skin-dried green-sand mould, 3 in. in diameter.

Table VII

Alloy.	Remelted without exposure.		Remelted after 12 months' Atmospheric Exposure.			
			With corrosion product.		*Without* corrosion product.	
	Density.	Pinholes.	Density.	Pinholes.	Density.	Pinholes.
Virgin Al.*	2.807	none	2.790	moderate	2.789	moderate
"3L11"	2.827	,,	2.789	bad	2.800	mod. few
"2L5"	2.969	,,	2.915	,,	2.945	,,
"Y"	2.746	,,	2.638	,,	2.689	bad
12 per cent. Si–Al	2.656	,,	2.597	,,	2.616	,,

* Virgin aluminium made up to 3L11 composition with degassed 50/50 Cu–Al temper alloy on remelting and casting.

The appearance of sections of some of these ingots, together with others from melts treated with steam, as previously mentioned, is shown in Fig. 4. In tests on larger melts of 300 lbs. in a gas-fired furnace, it was found that fairly satisfactory results are obtainable when the temperature does not exceed 700 deg. C. On heating to a pouring temperature of 760 deg. C., and continuing treatment, *e.g.*, with a mixture of chlorine and nitrogen, much less satisfactory results are obtained. It would appear that at the higher temperatures, with gas-fired melting pots, the rate of deterioration of the metal due to the absorption of furnace gases is more rapid than the beneficial action of the degassing operation. The necessity for a non-contaminating furnace atmosphere obtainable, for example, in an electric furnace, or by turning off the furnace burners after sufficient superheat has been obtained, is thus apparent whilst the degassing process is operated.

Claus[15] has shown that, by maintaining the melt at a temperature just above the melting point for some time in an electric furnace, much of the dissolved gas may be eliminated.

Fluxes

Several fluxes of a proprietary nature have been placed on the market for degassing aluminium melts. Hitherto few independent and authoritative reports as to their efficacy or commercial success have become available. In some cases their usefulness has undoubtedly been in question, since they have been supplied in a form in which contamination by moisture is inevitable, *e.g.*, their composition has included hygroscopic salts. R. Sterner Rainer[16] has proposed the use of a mixture of chemicals, their reaction on one another giving a liberation of chlorine. Typical mixtures suggested are boric acid plus alkali chlorides, which are stated to eliminate oxide skins by flotation as well as freeing the melt from gases. Other mixtures of easily-decomposed chlorides and bifluorides may be useful and liquid reagents of this type may be mixed with siliceous earth, asbestos wool, etc., in paste form.

Treatment with Volatile Chlorides

The use of boron trichloride has been developed by Tullis.[17] More recently Rosenhain, Grogan and Schofield[18] have examined the possible application of other volatile chlorides, including titanium tetrachloride. In addition to their use as degassing agents, certain of these compounds, *e.g.*, BCl_3 and $TiCl_4$, possess the property of conferring a fine grain in castings poured from the treated melt. In this manner, due both to the degassing and to the grain refinement, the serviceable properties of ingots and castings may be very substantially improved. With "Y" alloy, for example, the "working" properties of the metal are also markedly improved.

3L11. Not treated. | 3L11. Atmosphere of steam for 1 hr. at 700 deg. C. | 3L11. Steam bubbled in for 3 min. at 700 deg. C. | 3L11. Cl + N. 20 min. at 700 deg. C. | 3L11. Dry nitrogen. 20 min. at 700 deg. C.

Fig. 4.—Effect of various Treatments on the Incidence of Pinholes in 3L11 Alloy.

Table VIII.—*Effect of Furnace Treatment on Soundness.*

Treatment.	"3L11" alloy.		"Y" alloy.	
	Density.	Pinholes.	Density.	Pinholes.
None	2.771	moderate	2.714	moderate
Dry nitrogen, 20 min. at 700 deg. C.	2.795	few	—	—
Chlorine, ,, ,, ,, ...	2.817	very few	—	—
,, ,, ,, 640 deg. C.	2.827	sound	—	—
Nitrogen and chlorine, 5 min. at 700 deg. C.	2.805	few	2.743	nearly sound
,, ,, ,, 20 ,, ,, ,, ...	2.830	sound	2.748	sound
,, and bromine 15 ,, ,, ,, ...	2.834	,,	2.749	,,
Iodine, 4 gms. per lb.	2.810	few	2.739	very few
Presolidification in furnace	2.830	sound	2.750	sound

It will be appreciated from the number of methods which have been suggested—all within the last ten years—that the problem has been beset with many practical difficulties in the application of any of the methods to works practice. The investigations made have undoubtedly proved that complete degassing of the melt is possible and secures complete freedom of the casting from gas cavities. Most of the methods, however, involved the use of active gases, such as the halogens or compounds of the halogens, and the difficulties involved in the handling of these corrosive and toxic substances have prevented their extensive use. Moreover, methods completely successful on a laboratory scale have not always proved equally efficacious with larger melts in the foundry, because of the effects of mass and other complications. The problem of the development of a simple and reliable method for degassing treatment has received further investigation, and it is to be anticipated that progress in these investigations will be reported upon in due course.

Casting Technique

Developments in recent years regarding casting technique have resulted mainly from careful studies of the several factors involved relating to the actual pouring operation and to the process of the solidification of the ingot. The influence of casting temperature, speed of pouring, dimensional changes on solidification, feeding, mould conditions, mould materials and dressings have received attention in this connection. As a result, the empirical craftsmanship of the skilled foundryman has been replaced in some measure by more precise procedures less dependent upon the skill of the individual, whilst new developments both in foundry materials and methods have proved of practical and economic value. The responsibility for these developments lies not only with purely scientific investigators, but also with an army of practical and patient observers to be found among the personnel of every foundry.

Two features are encountered in the founding of aluminium alloys which are not so troublesome with many other metals and alloys. These are the relatively low density of aluminium and the inevitable presence of a tenacious and strong skin of aluminium oxide on the surface of the melt. The latter is a cause for much concern especially in the preparation of ingots required for subsequent hot or cold working.

Chill Castings for Subsequent Working

The need for a quiescent process in the casting of aluminium in which turbulence or pronounced motion in the mould is reduced to a minimum is essential, due to the effects of the oxide skin. This is particularly important when casting slabs and billets for subsequent rolling since troubles due to oxide skin in forming folds and splashes are much more marked in the preparation of wrought alloys than in sand castings. The Durville process[19] aims at avoiding turbulence by gradually and smoothly decanting the melt into the mould as the latter is slowly rotated from a horizontal position to the vertical. Various adaptations of this process are in

[13] D. R. Tullis. "Journal of the Institute of Metals," 1928, **40**, 55.
[14] D. Hanson and I. G. Slater. "Journal of the Institute of Metals," 1931, **46**, 187.
[15] W. Claus. "Z. Metallkunde," 1929, **21**, 268.
[16] R. Sterner Rainer. "Deutche Gesellschaft fur Metallkunde," June, 1931.
[17] D. R. Tullis. "Cindal" Aluminium Alloy Handbook.
[18] Rosenhain, Grogan & Schofield. "Journal of the Institute of Metals," 1930, **44**, 305.
[19] P. H. G. Durville. "British Patent," 23 719, 1913.

use. A very important feature in ingots for rolling and working is the macrostructure. When coarse columnar crystals are present, the ingot is more liable to crack and fail than when the crystals are fine and equiaxed. Internal shrinkage cavities are also a source of trouble, and in order to overcome these and other potential defects a number of castings processes have been suggested and developed, mainly in Germany. The development of the water-cooled copper mould as an alternative to the use of grey cast iron is due to Junker.[20] By control of the cooling-water supply, Junker aims at a slow rate of solidification at the commencement in order to give a flawless casting skin. Subsequently the rate of solidification is speeded up to a maximum in order to obviate large piping. Directional solidification from the bottom upwards is also aimed at. Erichsen,[21] in a modification of this principle uses mould plates of low-heat conductivity with warm-water cooling to give a somewhat less rapid rate of cooling. During solidification, the plates tend to buckle inwards so that a pressure is exerted on the ingot resulting in exudation of liquid metal in sufficient quantity to compensate entirely for shrinkage. Another method especially designed for aluminium alloys is the R.W.R. process of Roth-Wende and Ruttel[22] which aims at separating the pouring period sharply from the solidification period. The melt is solidified rapidly from the bottom face via a water-cooled copper plate and the whole mould is shaken at a definite amplitude and frequency. It is claimed that dissolved gases are eliminated and the macrostructure is completely refined by this process.

Gravity Die and Pressure Die Castings

Recent developments in casting technique in this field of aluminium founding have arisen mainly from improvements in mechanical and manipulative details. The design of dies for gravity and pressure casting has become a highly-specialised branch of mechanical engineering and has been built up on an essential basis of continued experiment and close observation. Since but few general rules in the design of dies may be said to exist, this accumulated experience has been the chief controlling factor in development.[23]

Some account of aluminium alloys specially adapted for die casting has been given previously. The characteristics of these alloys, particularly the percentage dimensional change on solidification and strength in the solid state at elevated temperatures just subsequent to solidification, are matters of very great importance and have received attention. The effect of dissolved gases in reducing the net shrinkage is an interesting observation, and can be used with due success under suitable circumstances. In this respect, the die caster may purposely favour the use of aluminium melts contaminated by a quantity of gas in preference to a gas-free melt, which is the ideal of the sand founder. It is not suggested that gassy melts are essential for die-casting practice, particularly since such material may prove deleterious in other respects, but as a simple expedient to overcome types of trouble due to shrinkage which cannot be avoided by more satisfactory means, here is a potential remedy.

The need for mould materials to withstand prolonged usage with a minimum of deterioration has been met in varying degree by developments in various alloy steels, including chrome-vanadium, chrome-tungsten-cobalt, tungsten-chrome, stainless and nitrided steels. Some account of these materials, together with observations on the "thermal fatigue" to which the die material is subjected, has recently been given by S. Tour.[24] Improvements in pressure die-casting machines have included general labour-saving equipment, power-operated die-opening mechanisms and ejectors, stationary ejector dies and movable cover dies, and the production of castings to greater dimensional accuracy.

Sand Castings

Recent developments in the production of sand castings have concerned matters relating to mechanical details of mould preparation and handling, and of more accurate control of foundry sands. In connection with the former, the foundry engineer has evolved and produced

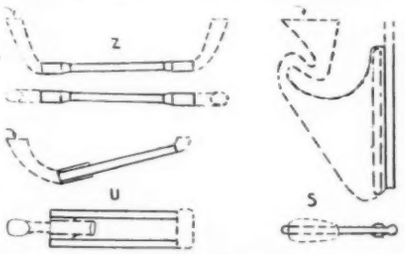


Fig. 5.—Types of Moulds used by Linicus and Schfur.

newer and better types of sand-handling and conditioning plant, moulding machines, special stripping devices and other auxiliary equipment, the main aim being directed towards general mechanisation. The lead in this matter has been derived mainly from the ferrous-castings industry, and is associated with mass-production methods of large and specialised manufacture. Owing to the very wide range of designs and types of castings handled in the average aluminium foundry, together with a more limited output, mechanisation has not been introduced to such an extent as is apparent in foundries producing iron castings.

Simple and reliable methods for sand testing have now become available, and they are being used to an ever-increasing extent for the more accurate and systematic control of foundry sands used in the aluminium and other founding industries. The valuable co-operation of the Institute of British Foundrymen[25] in developing these methods is specially to be noted. Synthetic sands are now successfully employed for cast iron and steel, and it is probable that their use may be extended to the aluminium industry, with consequent economies in the purchase of fresh supplies of natural sand. The possibilities of metallic sands which possess a greater heat conductivity have received some investigation.

A novel method of casting in sand moulds[26] has recently been described at the spring meeting of the Institute of Metals. It has been reprinted as a lengthy abstract in The Foundry Trade Journal.[27]

Relationship between Design of the Casting and Properties

The relationship between the design of a casting and its properties is of necessity a complex matter, and at the same time a very important one. The greater part of the data regarding the physical and mechanical properties of aluminium alloys has been obtained on specially-cast test-bars, and is not truly representative of the serviceable qualities to be expected in other forms of castings. Actual service experience with various castings has provided some information of a general qualitative nature as to the dimensions of this relationship. At the same time, there is a pressing need for more accurate information, so that some of the obscurities concerned in the so-called "factor of safety" with which the designer has to contend may be eliminated.

The testing of castings has received considerable attention during recent years,[28] but still remains a very controversial matter. Among the many factors which are to be considered in assessing the relationship between test-bar properties and the actual properties of the casting, there may be mentioned:—

(1) Differences in metallographical constitution both in macrostructure and microstructure due to variations in the rate of cooling.

(2) The influence of feeding and dimensional changes on solidification in their effects on the production of shrinkage cavities of various dimensions.

(3) The rate of cooling in suppressing or aiding the evolution of dissolved gases to form cavities of appreciable size.

(4) ernal stresses.

Some of these factors have been investigated to a limited extent. Devereux[29] has shown how the mechanical properties of "R.R." alloys and "Y" alloy when cast into 1-in. dia. test-bars, with various types of feeder heads, can vary quite considerably. Data obtained by Linicus and Scheur[30] with three types of chill moulds (see Fig. 5), in which five different alloys were cast, is summarised in Table IX.

Table IX.—*Influence of Mould Conditions on Physical Inspection.*

Alloy.	Shape of mould.	Proof stress, tons/in.²	Ultimate strength, tons/in.²	Elongation per cent.	Hardness.	Fatigue* range, tons/in.²
8 per cent. Cu–Al	U	5.14	11.0	3.8	69	5.1
	S	5.4	13.3	5.3	70	4.1
"Schrott" alloy	U	6.4	10.2	1.5	68	2.9
	S	7.3	13.1	2.2	74	4.8
"Deutsche alloy," Cu 2 per cent.; Zn 12 per cent. ..	U	4.7	8.1	3.5	61	—
	S	4.4	10.8	8.2	58	—
Modified silumin	Z	8.3	16.2	4.2	73	—
	U	7.1	14.2	4.5	64	4.8
	S	5.8	13.8	6.9	64	4.1
Silumin gamma, heat-treated	Z	17.6	20.2	1.0	110	—
	U	—	—	—	—	7.9
	S	16.9	20.5	1.2	109	6.67

* Basis 20,000,000 cycles.

The differences observable in each alloy cast in the various moulds are very remarkable. From further tests it is shown that fatigue tests on specimens cut from a series of larger Silumin castings give values some 10-20 per cent. lower than those obtained on specially-cast bars. The authors conclude from the greater sensi-

(*Concluded on page* 226.)

20 O. Junker. "Z. Metallkunde," 1926, **18**, 312.
21 Erichsen. British Patent Nos. 358697, October, 1931, and 299,850, May, 1929.
22 Kessner, "Metallwirtschaft," 1932, **11**, 583.
23 See C. Vaughan. "Production of Gravity Die and Pressure Castings in Aluminium." "Metal Industry," 1933, **42**, 125. M. Stern. "Progress of Die-Casting Industry." "Trans. Amer. Foundrymen's Assoc.," December, 1930, 723.
24 S. Tour. "Steels for Die-casting Dies." Amer. Inst. Min. and Met. Eng. Tech. Pub. 568, October, 1934.
25 "Journal of the Institute of British Foundrymen." Proc. 1932–33, **26**, 61.
26 Hanson & Slater. "Solidification of Aluminium Alloys under Pressure in S nd Moulds." Institute of Metals Spring Meeting, 1935.
27 Foundry Trades Journal, March 14, 1935, page 185.
28 See W. Rosenhain. "The Testing of Castings and General Discussion." Journal of the Institute of Metals," 1932, **48**, 273.
29 W. C. Devereux. "Methods of Manufacture and their Influence on Design." Institute of Metals, Scottish Local Section, November 12, 1934.
30 Linicus and Scheur. "Die Wechselfestigkeit von Leichtmetallguss. Metallwirtschaft," 1934. November, XIII, Heft. 47 and 48, pp. 829–836 and 849–855.

The British Iron and Steel Federation

ANNUAL DINNER IN LONDON

The annual dinner of the British Iron and Steel Federation was held last Thursday at Grosvenor House, Park Lane, when the Earl of Dudley (the new President) presided. H.R.H. the Prince of Wales, K.G., was the principal guest, others including The Rt. Hon. Lord Greenwood, K.C., The Rt. Hon. Sir Robert Horne, M.P., Lt.-Col. J. Colville, M.P., The Rt. Hon. Lord Weir of Eastwood, Sir George May, Bt., K.B.E., Sir Arthur Balfour, Bt., Sir Frederick Mills, Bt., M.P., Sir Peter Rylands, Sir Wm. Gowers, The Hon. R. D. Kitson, D.S.O., M.C., Sir Herbert Walker, K.C.B., Mr. J. Henderson, Mr. W. R. Lysaght, Mr. A. J. Grant, Mr. A. O. Peech, Sir John Beale, K.B.E., Mr. A. Dorman, Mr. W. Benton Jones, Capt. R. S. Hilton, Mr. J. E. James, Mr. L. Ennis, C.M.G., O.B.E., Mr. H. Summers, Mr. A. Williamson, and others.

H.R.H. The Prince of Wales

H.R.H. The Prince of Wales, K.G., proposing the toast of "The Iron and Steel Industry" said he could claim to have visited the most important steel-manufacturing plants in this country and even if he had not understood or mastered the many technicalities, at least those who were kind enough to conduct him round had been at pains to explain them to him to the best of their ability. Again, as a naval cadet he had handled various forms of the products of the iron and steel industry when he served four years' apprenticeship in the machine shops and he well remembered the thrill of the experiments on the testing machines and he also remembered even better the nature of the calculations afterwards. That, however, was more than 25 years ago and the industry was making better steel now. In fact, it was making such good steel that it was difficult to exaggerate the growing importance of iron and steel in our modern civilisation. The amazing developments in transport by sea, land and air, whether it be on the "Queen Mary," or in one of our great railway locomotives or in some of the aeroplanes of Imperial Airways, had all been rendered possible by the achievements of the industry in the manufacture of new materials in the way of steel. Again, if we took agriculture, that was dependent upon steel not only for mechanical implements but in the use of tinplate for canning vegetables and fruit, an important development in increasing agricultural production in this country. Indeed, it was possible to mention many instances in which steel had replaced wood, but it was perhaps only necessary to mention the masts of ships and the shafts of golf clubs.

What interested him most, however, continued His Royal Highness, were the results of the co-operation of the industry with architects and the building trade with the object of securing standardisation of housing construction. He had seen this going on himself and he knew how it was helping to solve some of our housing slum clearance problems on the most efficient and economical lines. In this connection he mentioned the Council for Research on Housing Construction which the Federation was taking such an active part in.

How had these advances been made? How had the development of high-tensile steel been made possible? He was satisfied that it had only been made possible by research and with all humility, in face of hundreds of experts, he submitted the importance, nay, the necessity of the research departments of the various firms in the industry without which it was impossible to keep pace with the development of modern manufacture. He stressed this point because he had occasionally—but only very occasionally—when visiting manufacturing plants, found that the research department had been closed for reasons of economy but he ventured to say that this was false economy.

The products of the iron and steel industry played such an important part in our daily life that the movements of the industry, whether towards prosperity or depression, were a true reflection of the economic well-being of the country. Consequently, he was glad to be able to congratulate those in the industry on the progress made towards recovery during the past two years. Production had increased very substantially last year and the export trade had been increased by 20 per cent. in the same period. If his figures were correct, then these results bore remarkable testimony to the efforts that had been made during a long period of depression in maintaining and improving productive efficiency. These had made it possible for the industry to take immediate advantage of improved conditions and to respond to a very rapid development in demand. Nevertheless, despite this improvement we were all still

The Earl of Dudley
(President, British Iron and Steel Federation).

deeply concerned at the stagnant high figure of unemployment, and it must be a source of gratification to the industry to know that as the result of the efforts that had been made and of the improved conditions during the past two years, unemployment in the iron and steel trades had been reduced from 45 to 25 per cent.

In conclusion, His Royal Highness wished the Federation and the industry every possible success in the future in the hope that this would benefit not only the industry but the whole of Great Britain. He coupled the toast with the name of the President of the Federation, the Earl of Dudley, and congratulated the Federation on the wisdom of its choice of President.

President's Reply

The President, in his response, said that in his most eloquent and inspiring speech His Royal Highness had set a splendid objective to the industry and to the new Federation which they should strive consistently to attain both in their own and in the national interests, viz., the fullest co-operation for the common good in every sphere of their activities. Though we must admit that we have still some way to travel and many difficulties to overcome before we can attain the full realisation of that ideal, yet he thought we might justly claim that great and satisfactory progress had already been made. The Federation, which was brought into being on Armistice Day, was the first effort at comprehensive co-operation on the part of the industry. During the seventeen years of its life, experience showed conclusively that under modern conditions, confidence and prosperity could be maintained only by co-operation rather than by competition. But the difficulty of reaching an ideal would be realised when it was remembered that what was generally described as the iron and steel industry was not one industry but a large group of industries, some fifteen in number, each performing an individual function, their only connection with each other being the conversion of the materials of one into more highly-finished forms by the other; therefore, the reconciliation of many apparently conflicting interests presented no light problem.

Without undue optimism, however, he thought it could be claimed that the newly-constituted Federation—to which all the varying Trade Associations, which formed the component parts of the industry, were rapidly becoming affiliated—would eventually by goodwill and mutual understanding become so closely welded one to another as to achieve a truly efficient form of self-government. Whilst the Associations to which he had referred were autonomous in the regulation and control of the interests which they were designed to serve, their affiliation to the Federation not only implied an obligation on their part but also provided the means of acting in concert on all matters of common interest, to promote the highest possible pitch of efficiency in the industry as a whole, and utilise the influence and experience of all to the benefit of each.

Reference had been made by His Royal Highness to the progress that had been made during the past two years, and he was glad to be able to report that the present year opened with a continuity of that progress, steel production showing an increase of 8 per cent., pig-iron of 17 per cent. and our export trade an increase of 16 per cent. over the corresponding period of last year. But although we were hopeful that these encouraging indications might continue, yet we must not lose sight of the fact that our prosperity depends to a large extent upon national and international influences, over which, as an industry, they could not possibly have any control. Unfortunately, at the present time, many of them showed anything but promising portents. Some of these influences, indeed, were responsible for that increasing import percentage which had been causing the Federation considerable anxiety and alarm, but it was hoped that the measures announced that day would be the means of adequately adjusting that adverse figure in our favour. Of one thing he was certain, in no way was it due to any lack of productive efficiency, and he was confident that British productive plant compared favourably with that of any other competing country, and still maintained that lead in productive genius which it had held uninterruptedly since the earliest days of iron smelting. We were proud to remember that we still had records of furnace outputs which had never been beaten nor even equalled by our friends abroad.

This record was due not only to our national engineering and metallurgical faculty, but also to the activities of the Iron and Steel Industrial Research Council, a nation-wide organisation founded by the old Federation and embracing every single branch of the industry. In this connection they gratefully acknowledged the ungrudging and full co-operation of most of the distinguished scientists whose work had any connection whatever with the problems of the industry. The industry had established a Research Organisation which, in character and effectiveness, was second to none, and either directly or through the Iron and Steel Institute, they were in touch with every scientific and technical society throughout the world, and on a reciprocal basis they had the full benefit of their experience and discoveries. The President said he wished to lay emphasis upon this, as he believed it to be a popular illusion that the British iron

We Manufacture

MOLYBDENUM STEEL CASTINGS

HIGH TEMPERATURE SERVICE

RESISTANCE TO CREEP.
INCREASED STRENGTH.
RESISTANCE TO SHOCK.

Further information supplied on receipt of your application :

VICKERS-ARMSTRONGS LIMITED

BARROW-IN-FURNESS

WARNER C.P.B.R.

CYLINDER PIG IRON

"The brand of proved reliability"

Supplied to specifications covering a wide range of requirements and employed by the leading Railway Co's Roll Makers and Engineering Founders.

WARNER & CO. LIMITED

CARGO FLEET MIDDLESBROUGH

and steel industry lags behind its competitors in regard to scientific research and experiment.

His Royal Highness had referred to the economic value of standardisation in modern industry, and this important question continued to be vigorously dealt with by the British Standards Institution. But, although standardisation in the use and manufacture of iron and steel could lead us far in the direction of lowering costs and increasing efficiency, it seemed that the variations of demand both in quantity, quality and form must always remain wide and diverse, and this in itself was in direct conflict with the cheapest methods of production. Some individual firms, indeed, were called upon to deliver steel to as great a variety of analyses as the prescriptions of a chemist, and it was difficult to see how these analyses, each of which had its own particular use, could be largely reduced by standardisation. In spite of these difficulties, however, steel was undoubtedly becoming a cheaper and more applicable commodity, and was day by day being put to more varying uses than our forefathers or even our fathers would even have visualised. Concluding, the President said the new organisation of the Federation, by reason of its solidarity and its goodwill, had made it possible to develop a degree of inter-Imperial and international co-operation hitherto impossible. They looked forward to playing their part in promoting agreements between the iron and steel industries of the world, having as its object co-operation in the development of world markets and the elimination of uneconomic competition. The ability to achieve this objective had undoubtedly been enhanced by the progressive policy of H.M. Government, of which there had been further evidence in the announcement that had been made that day.

The Rt. Hon. Lord Greenwood, K.C., proposed "Our Guests," and, referring to the Import Duties Advisory Committee, said he regarded this as the most important committee in English commercial history, because we were the only country that had attempted to establish a tariff by an independent tribunal. This made it very difficult, in his opinion, to alter the various laws, which he hoped would grow in number, in reference to tariffs if the advice of this independent Tribunal was followed. Continuing, Lord Greenwood said that, as a newcomer to the iron and steel industry, he expressed, what all must feel, a heartfelt gratitude to the Government for helping to re-establish this vital industry, and it would ill become those in the industry to fail to carry on the spirit of the Government policy in putting their own house in order to make permanent the advantages that were coming their way.

The Rt. Hon. Sir Robert Horne, C.B.E., M.P., who responded, referred to the improvement made recently in the iron and steel trade, but added that an even more significant fact was that in 1934 the production of iron and steel was an improvement over the production for 1924, which was a very good year. That was a very remarkable thing which he did not think was realised in this country at the present time. Our position to-day, taking industry as a whole, was better than it had been at any period during the last 10 years. Our factory production last year was the biggest on record in English history. He maintained that this was due to the tariff, and he doubted whether anybody could ever disagree with the idea of a tariff now. Imagine what would have happened to us in this world of quotas if this country had been the only one with open shores available upon which to turn the surplus production of other countries? There was one disconcerting element in the record last year, viz., the increase in imports of manufactured steel, but the industry had been very lucky to obtain through the activities of the Import Duties Advisory Committee a safeguard against that.

The final toast of "The President" was proposed by Lt.-Col. Colville, M.P. (Secretary, Department of Overseas Trade), who, after congratulating the Federation upon having Lord Dudley as its President, and referring to the long traditional interest of his family in the iron, steel and coal industries, together with his activities in so many other directions, said there was one aspect of the work of the Federation to which he wished particularly to bear testimony, viz., the governing principle to promote the closest co-operation between the Government of the day and industry. This he believed to be not only a national service, but the only possible means whereby we can lay a solid foundation for economic recovery.

The President briefly acknowledged the toast.

Those present included the following persons prominent in the foundry industry:—

Sir H. Austin, Mr. M. F. Barnard, Mr. M. S. Birkett, Mr. H. Brearley, Mr. P. B. Brown, Col. J. Colville, Mr. H. E. Cookson, Comdr. Sir C. W. Craven, Mr. V. Delport, Dr. C. H. Desch, Mr. W. E. Dobson, Mr. A. Dorman, Mr. V. C. Faulkner (Past-President, Institute of British Foundrymen), Mr. C. W. Fellows, Mr. E. J. Fox, Sir H. Hartley, Dr. W. H. Hatfield, Mr. K. Headlam-Morley, Mr. P. B. Henshaw, Capt. R. S. Hilton, Mr. Barrington Hooper (Managing Director, The Foundry Trade Journal), Mr. J. E. Hurst (Vice-President, Institute of British Foundrymen), Mr. H. J. Kennard, Mr. J. S. Kerr, Sir W. J. Larke, Mr. S. C. E. Lloyd, Mr. H. W. Lockwood, Mr. W. R. Long, Mr. G. T. Lunt, Mr. A. C. Macdiarmid, Dr. A. McCance, Mr. A. N. McQuistan, Dr. H. Moore, Mr. R. H. Myers, Mr. J. G. Pearce (Director, British Cast Iron Research Association), Sir J. Petavel, Mr. W. Reavell, Mr. F. S. Russell, Mr. T. M. Service, Mr. J. Smith, Mr. W. H. Smith, Mr. R. Stubbs (President, Institute of British Foundrymen), Dr. T. Swinden, Mr. H. B. Toy, Mr. B. Walmsley, Mr. S. Walton (Director, The Foundry Trade Journal), Mr. J. Ward, Rt. Hon. Lord Weir of Eastwood, Mr. G. E. Wells, Mr. H. Yates.

Refractories Association

The sixteenth annual dinner of The Refractories Association of Great Britain was held on Wednesday night of last week at the Grosvenor Hotel, Park Lane, London. This was the first time that the function had not been held in Sheffield. The early part of the proceedings was presided over by Mr. Alex. Lomas, who deputised for his father, Mr. William Lomas, J.P., the president, who is 94 years of age. During the evening Mr. F. Metcalfe Fisher was inducted into the chair. Excellent speeches were delivered by Mr. Herbert Wragg, M.P., Mr. Whytehead Boulton, M.P., Sir Ronal Matthews, J.P., Mr. Louis W. Smith, M.P., Bailie Phillip McDevitt and Mr. H. J. C. Johnston. Amongst those present prominent in foundry circles were:—

Mr. J. E. Hurst and Mr. H. Winterton (vice-presidents of the Institute of British Foundrymen), Mr. Vincent C. Faulkner (past-president, Institute of British Foundrymen), Mr. A. Whiteley and T. R. Walker, B.A., Mr. C. H. Kain, Mr. A. C. Turner, Mr. F. S. Russell, F.G.S., Mr. W. J. Rees (who acted as Toastmaster), Mr. Van Marle, Mr. J. S. Kerr, Mr. F. E. McGrah, Mr. S. Grayson, Mr. F. J. Barraball, Mr. A. J. Arnold, Mr. A. V. Goddard and Mr. W. E. Dobson.

Recent orders received by the Engineering Department of Messrs. Edgar Allen & Company, Limited, Imperial Steelworks, Sheffield, include:—A rotary kiln for cement works in Australia; two rotary kilns for installation in this country; eight stag tube mills for the Rand; two Edgar Allen-Buell rotary dryers for abroad; and two vibrating screens for a limestone quarry plant.

British Standard Pump Tests

The British Standards Institution has just published a British Standard Specification for Pump Tests designed to cover the determination of the performance and efficiency of pumps when handling clean water at temperatures up to 85 deg. Fah. The specification has been based on the Standard Pump Test Code of the Standards Association of Australia, and, whilst at the moment there are differences between the two documents made to conform with present-day British practice, it is hoped that in due course the two may be brought into line.

The specification sets out the mechanical and hydraulic conditions to be observed and precautions to be taken during a test. The measurement of a pump discharge, *i.e.*, the rate of flow, is treated at length, and the following methods are dealt with in detail:—Volumetric; vee-notch weirs; rectangular weirs; Venturi meters; flow nozzles; orifice gauges; and Pitot tubes. In each case formulæ for the calculation of the discharge are stated, also the methods to be employed and precautions to be taken to ensure accuracy are laid down. Further, the limits within which the formulæ can be relied upon for accurate results are definitely specified, as are also the limits of accuracy in each case. The measurement of "head" is dealt with at length and comments are made on the use of gauges in the determination of this.

The specification also deals with the measurement of the power input to, and the efficiency of, a pump. Finally, the tolerances allowed on test results are specified. Tables giving the discharge over 90-deg. and half-90-deg. Vee notches are included.

Appendices have been included outlining the information which should be supplied to makers with inquiries or orders and giving a suggested standard form of pump test-sheet which incorporates all the information usually required. A table of water densities at various temperatures is also included for the convenience of users, together with notes on centrifugal-pump characteristic curves.

Copies of this Specification (No. 599—1935) can be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 2d. post free.

Recent Advances in the Founding of Aluminium Alloys

(*Concluded from page* 223.)

tivity to casting conditions of the non-eutectic alloys that such alloys will show appreciably bigger differences, and in this connection confirm the observations of Devereux. Incidentally, this Paper by Linicus and Scheur contains a very comprehensive summary and discussion of matters relating to the properties of the more generally-used aluminium alloys.

Observations of this nature assist not only in supplying useful data on the relative properties of castings, but also in directing the efforts of the foundryman towards securing more satisfactory methods of casting technique.

Important developments at the works of Messrs. W. Beardmore & Company, Limited, Parkhead, Glasgow, are foreshadowed in the plans which have been prepared by the firm for the modernisation of three furnaces. Messrs. Beardmore have in recent years been steadily concentrating their efforts on the production of heavy-steel castings. It is to meet the market in this direction that they have under consideration the rebuilding of three furnaces so as to permit the making of castings up to 120 tons in weight. At present heavy castings of 70 tons and over have to be cast from three furnaces. The furnace alterations will necessitate the erection of a new gas plant, and the alterations all told will involve a considerable expenditure. Messrs. Beardmore have of late experienced very much improved trading conditions.

WM. CUMMING & CO. LTD.

Established 1840.

The Leading Manufacturers!
The Oldest Established!!
The Most Reliable!!!

Ironfounders' Facings Manufacturers and General Foundry Furnishers,

Kelvinvale Mills, Maryhill, GLASGOW

Branches at Falkirk, Chesterfield, Deepfields and Middlesbrough

CUMMING'S CFF FOUNDRY FACINGS

CUMMING'S CPP PARTING POWDER

CUMMING'S CCC CORE COMPOUND

CUMMING'S CRIC RELIABLE IRON CEMENT

SUPERFINE COAL DUST

SUPERLATIVELY REGULAR IN GRIST.
SUPERIOR IN QUALITY.
SEVEN GRISTS STANDARDISED.
ONE QUALITY OF COAL THROUGHOUT.

INGOT MOULD BLACKING

THE BEST ON THE MARKET.
MANUFACTURED BY THE NEW PROCESS.

BRITISH PLUMBAGOS

AT LOW PRICES.
IMPORTED DIRECT.
NO CONTINENTAL ADULTERATION.

POWDERED CORE GUM

BRITISH MANUFACTURE.
BEST QUALITY.

CUMMING FURNACE

USERS OF THE NEW "CUMMING" FURNACE ARE INCREASING WEEK BY WEEK.

CORE COMPOUNDS, PARTINGS, CUMMINGSTONE, REQUISITES, BLACKINGS for every PURPOSE

ALL OUR OWN MAKE

This Week's News in Brief

Trade Talk

GLASGOW CORPORATION has placed a contract with the Staveley Coal & Iron Company, Limited, for the supply of 92 tons of cast-iron water pipes.

THE ADDRESS of the Office of Trade Boards on and from April 2 will be Romney House, Marsham Street, London, S.W.1 (telephone number unchanged).

DAMAGE WAS CAUSED by a fire which occurred in the iron foundry owned by Mr. David Totton, at Mary Street, Portadown, Northern Ireland. The outbreak was confined to a small part of the foundry.

H.M. DESTROYER "FORTUNE," built by Messrs. John Brown & Company, Limited, Clydebank, designed for a speed of 35 knots, with a displacement of 1,400 tons, underwent trials on the Clyde this week.

ARRANGEMENTS ARE BEING MADE for a Conference of The Institute of Vitreous Enamellers to be held in Glasgow on June 8, 9 and 10, for the purpose of the inauguration of the Scottish Section of the Institute.

TO MEET THE DEMANDS for their famous "Stuart" castings, Stuart Turners, Limited, of Henley-on-Thames, are adding to their moulding-machine equipment, as the new foundry has already proved inadequate for the firm's requirements both in ferrous and non-ferrous castings.

AN ORGANISED VISIT of the members of The Institute of Vitreous Enamellers to the Rugby works of the British Thomson-Houston Company, Limited, has been arranged for Thursday, April 11, at 2.30 p.m., members to meet at the main entrance. Miss E. Christine Elliot, the honorary general secretary, will be glad to hear from those who are desirous of attending, so that the necessary arrangements can be made.

WITH HER ENGINES, boilers, dredging machinery and even the funnels in position, the "Onger," a twin-screw drag and cutter suction dredger, was launched from the Renfrew yard of Messrs. William Simons & Company, Limited. The vessel has been built for the Crown Agents for the Colonies, acting for the Basrah Port Directorate at Basrah, Iraq. The vessel is 300 ft. in length and one of the most powerful dredgers built on Clydeside since the war.

THAT HIS COMPANY had been asked to increase prices and to form a Prices Association, was revealed by Mr. David Frame, managing director of the Hammond Lane Foundry Company, Limited, Dublin, giving evidence before a sitting of the Free State Prices Commission. He added that he would have nothing to do with the proposal. On the question of price-cutting, Mr. Frame said, if they did that, they would be accused of trying to create a monopoly and cut out the little firms in other parts of the country.

RECENT ENGINEERING and metallurgical developments in Glasgow are dealt with in an interesting brochure, "New Products and Processes," issued by the Development Board for Glasgow and District. Of particular interest are recent developments at the works of Messrs. Mirrlees Watson & Company, Limited, where the process of nitriding has been in operation, and the new product is a small high-speed steam turbine. Messrs. Mirrlees Watson are the only authorised nitriding firm in Scotland. The Laystall hardened-steel liner manufactured by the firm has made much headway in the reconditioning of work brake drums. Its non-scoring properties have been demonstrated over mileages hitherto considered impossible. Recent extensions in Messrs. Mirrlees Watson's nitriding department have brought the capacity to four furnaces, of which the largest accommodates lengths up to 6 ft. The brochure also deals with developments in the motor-vehicle industry, fusion welding, coloured cements, etc.

TO A FALKIRK ironfounding firm has fallen the distinction of supplying the bath for the house which is to be the Silver Jubilee Gift of the Royal Warrant Holders to His Majesty the King. The bath, which is being supplied by Messrs. M. Cockburn & Company, Limited, Gowanbank Ironworks, Falkirk, to the order of the Leeds Fireclay Company, Limited, Royal Warrant Holders, is of unique and extremely pleasing design, and constitutes a perfect example of art in ironfounding. It is an altogether new type of luxury bath, made, of course, of cast iron, and beautifully enamelled in pale green. It has been sent off for exhibition in the house on display at Olympia. There are two principal bathrooms laid out in the King's Jubilee House, the one fitted up by the Leeds Fireclay Company, including the bath from Falkirk, and the other by the well-known Doulton firm.

THE WORKS of the Motherwell Iron & Steel Company, Limited, have been sold for scrapping to the Motherwell Machinery & Scrap Company, Limited. The plant is to be dismantled and such parts as are in good running condition will be offered for sale for use elsewhere. The Motherwell Iron & Steel Company was founded and directed by local men, and all the workmen were employees of long standing. The company had a successful history in its earlier years, and during and after the war large plant extensions were undertaken. The company's fortunes improved considerably last year, although a loss was incurred. Suddenly, on November 9 last year, a notice was posted intimating that, "owing to circumstances beyond our control, operations at these works have now ceased." A liquidator was appointed, and the plant advertised for sale. Negotiations between Glasgow and Birmingham groups were unsuccessful, and it was ultimately decided to sell the plant for dismantling. The purchasing company is connected with Messrs. Colvilles, Limited.

Personal

MAJOR R. A. BRIGGS is now a director of Qualcast, Limited.

DR. ANDREW M'CANCE has been re-elected chairman of the West of Scotland Iron and Steel Institute.

MR. AND MRS. J. B. NEESHAM have celebrated their golden wedding. Mr. Neesham is the well-known inventor of the foundry pneumatic moulding machine, which was patented in 1893.

THE MEMBERS of the Bathgate branch of the National Union of Foundry Workers honoured their ex-secretary, Mr. Peter Dalglish, last week by presenting him with the gold badge of the union and a wallet of notes. Mr. David Ford presided and Mr. M'Bain, Scottish organiser, made the presentation.

MR. J. DAVENPORT has been appointed manager of the steel foundry of Messrs. Hopkinsons, Limited, of Huddersfield, and will take up his duties on April 1. In this connection, the Farington Steel Foundry of Leyland Motors, Limited, of which Mr. Davenport was the manager, have advised their customers that they can accept no further orders for steel castings after March 30, and requesting that they continue to support Mr. Davenport at his new concern.

Contracts Open

Egypt, April 15.—Supply and laying of 700 metres of 150 mm., 750 metres of 100 mm., and 24 metres of 80 mm. dia. cast-iron pipes, together with specials, valves and hydrants, for the Ministry of the Interior. The Department of Overseas Trade. (Reference G.Y. 14,949.)

Newport Pagnell, April 1.—Providing and laying 350 yds. of 6-in. iron water mains, etc., for the Rural District Council. Messrs. Taylor & Wallin, 1, Saville Place, Newcastle-upon-Tyne. (Fee £5 deposit, returnable.)

Wycombe, April 3.—The Wycombe Rural District Council invites tenders for the supply and delivery of spigot and socket spun iron pipes, coated inside and out with Dr. Angus Smith's solution, the following lengths being required:—About 1,216 lineal yards, class E, 6 in. dia.; 2,800, class C, 5 in.; 1,765, class B, 4 in.; 2,345, class C, 4 in.; 1,200, class E, 4 in.; 6,050, class C, 3 in. The Water Engineer, Council Offices, 17, High Street, High Wycombe.

Buenos Aires, April 10.—Arc-welding equipment, for the Argentine State Oilfields. The Department of Overseas Trade. (Reference A.Y. 12,969.)

Wycombe, April 3.—The Rural District Council invites tenders for the provision and erection of a centrifugal borehole pump and electric motor, horizontal turbine pump and motor, two booster pumps and motors, booster tanks, with automatic electric control equipment, etc. The Council's Offices, 17, High Street, High Wycombe. (Fee £2 2s., returnable.)

Company Reports

British Thomson-Houston Company, Limited.—Profit, after tax provision, £356,433; brought in, £229,443; depreciation, £122,738; dividend of 3 per cent. on the ordinary shares; carried forward, £250,813.

Gibbons (Dudley), Limited.—Net profit for 1934, after depreciation, £12,746; brought in, £10,195; 7 per cent. preference dividend, tax free, £2,100; dividend of 8 per cent. on the ordinary shares, less tax; carried forward, £12,099.

British Insulated Cables, Limited.—Profit for 1934, £558,760; brought in, £300,724; dividend of 10 per cent. on the ordinary shares, making 15 per cent. for the year; to reserves and depreciation account, £200,000; carried forward, £301,000.

Thos. Firth & John Brown, Limited.—Trading profit, £483,458; net profit, £345,039; brought in, £17,882; dividend of 5 per cent., tax free, on the ordinary shares; to general reserve, £50,000; carried forward, after meeting preference dividend to end of 1934, £46,021.

British (Guest Keen Baldwins) Iron & Steel Company, Limited.—Trading profit, £356,261; directors' fees, £2,000; establishment charges on idle works, £6,433; special repairs, etc., £46,461; depreciation, £70,000; special expenditure, £6,235; profit balance, £225,132.

Obituary

SIR GEORGE CLARK, BT., D.L., died at his residence in Belfast on March 23, at the age of 74. A son of the late Mr. James Clark, of Paisley, he went to Belfast over 50 years ago, and was one of the founders of the shipbuilding firm of Workman Clark & Company, Limited.

MR. WILLIAM W. M'COSH died at his residence, Easter Moffat, Plains, near Airdrie, on Sunday, March 17. Mr. M'Cosh, who was a son of the late Provost M'Cosh, Coatbridge, was one of the principals in the firm of William Baird & Company, Limited, Gartsherrie Ironworks, and devoted most of his time to the interests of the works. He was also a director of Baird's Mining Company, Limited, and the Caledonian Portland Cement Company, Limited. Mr. M'Cosh was educated at Cambridge. He served on Coatbridge Town Council for one term, and was a magistrate when he retired from that body.

IT IS WITH DEEP REGRET that we announce the sudden death of Mr. W. H. Wood, a director of the Constructional Engineering Company, Limited, of Titan Works, Birmingham, at the advanced age of 80 years. With a wide engineering experience of some 45 years, Mr. Wood, sen., joined Mr. D. H. Wood in the Constructional Company shortly after its commencement in 1911, and since that time he has been actively and intimately connected with the growth and progress of the business. To Mr. D. H. Wood, who is so well known in engineering circles, we extend the very deep sympathy of the whole of the foundry industry.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Albion Metal Traders, Limited.—Capital £1,000. Steelmakers and ironfounders. Director: G. H. Taylor, Finsbury Court, Finsbury Pavement, E.C.2.

Quality Steels (London), Limited.—Capital £100. Manufacturers of and dealers in metal, etc., brassfounders and ironmasters. Subscriber: E. Penn, The Jordans, Digby Road, Sutton Coldfield.

Pirie Parlanti & Company, Limited, 19, Charing Cross Road, W.C.2.—Capital £100. Iron and brass founders, boiler, turbine and engine makers. Directors: I. B. M. Pirie, C. A. Parlanti, N. T. Helme and L. S. Seccombe.

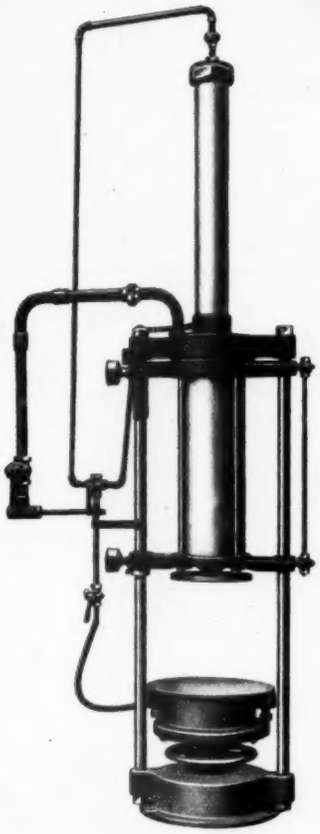
Cannon Iron Foundries, Limited.—Capital £100. Ironfounders, hollow-ware manufacturers, etc. Directors: Sir Francis H. Pepper, Kt., The Oaks, Handsworth Wood, Birmingham; R. D. B. Clayton, F. E. S. Clayton, R. T. Clayton and W. E. Hawthorne.

THE STAVELEY COAL & IRON COMPANY, LIMITED, Chesterfield, have secured a contract for the supply of concrete-lined cast-iron pipes to the Sheffield Water Department.

XUM

THE "ROCKET" PATENT CORE MAKING MACHINE

BLOW THE CORES! MAKE SURE OF YOUR REQUIREMENTS



3 REPEAT ORDERS IN 5 MONTHS FROM 1 FOUNDRY

Consider the following in relation to your own Core Making

PREVIOUS OUTPUT	THE "ROCKET" OUTPUT
One Core in 17 minutes	200 Cores in 8 hours

Full particulars apply:

FOUNDRY ENGINEERS LTD.,

HALIFAX, YORKS.

Telephone: 61459 Halifax

Telegrams: "FEL," Halifax

Raw Material Markets

Under the Additional Import Duties (No. 6) Order, issued by the Treasury on the recommendation of the Import Duties Advisory Committee, increased import duties came into force on Tuesday on certain elementary iron and steel products, including blooms, billets and slabs, bars and rods, angles, shapes and sections, girders, beams, joists and pillars, hoop and strip, and rails. The duties on these products now range from £2 to £4 per ton. A firmer tone has been noticeable in the markets since the news of the above duties became known, as the producers of the classes of goods in question stand to benefit considerably by the change.

Pig-Iron

MIDDLESBROUGH.—The expected spring demand for foundry iron has yet to get into its stride, and export business is still very sparse. Fortunately, the current demand is sufficient to absorb practically all of the Cleveland output, and unsold stocks at the works are not yet large enough to give cause for concern. Few new contracts have been arranged lately, but it is expected that business will revive very shortly, as a number of large contracts have practically run out. Transactions with British buyers are all regulated by the agreed minimum scale of prices, which, for No. 3 Cleveland G.M.B., is 67s. 6d. per ton delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk, and 70s. 3d. delivered Glasgow. For No. 1 foundry grade 2s. 6d. per ton extra is charged, and 1s. per ton discount is allowed on No. 4 foundry and No. 4 forge iron.

A rather stronger demand for East Coast hematite has been noticeable this week, and makers have strengthened their order-books over the second quarter of the year. On the other hand, export trading remains poor, and the Italian restrictions have not improved the outlook. For export, hematite prices are not fixed, but home prices of No. 1 East Coast quality range from 69s. per ton delivered Middlesbrough to 79s. delivered Birmingham, mixed numbers being 6d. per ton cheaper than No. 1 grade.

LANCASHIRE.—The Lancashire market for foundry iron has been rather more active this week. A slightly better demand has been forthcoming from certain sections of the consuming trades, and a certain amount of forward business has also been arranged, with prospects of more to follow. In the meantime, the market is steady all round, Staffordshire, Derbyshire and Lancashire brands of No. 3 iron equal to Derbyshire all being quoted for delivery to Lancashire foundries on the basis of 74s. per ton, Northamptonshire at 72s. 6d., West Coast hematite at around 78s. 6d., and East Coast at from 75s. to 76s., according to grade.

MIDLANDS.—Although there is still room for expansion, activity in the iron-consuming trades in the Midlands is gradually improving. The general engineering and jobbing trades continue to make progress. There have been no changes in values. The controlled prices of Midland foundry irons of ordinary quality are 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, delivered to Birmingham and Black Country stations, and subject to a graduated rebate for large consumers. Other grades of pig-iron are not subject to control, and the prices vary considerably according to analysis, tonnage and the carriage from the furnaces. The three groups are:—Medium phosphorus, at 72s. to 80s.; low phosphorus, at 85s. to 87s. 6d., including Scottish No. 3 at 85s., and special refined pig at any price from £5 7s. 6d. delivered to this district.

SCOTLAND.—Reports from the Glasgow iron market indicate that business is mainly on current account, consumers showing little inclination to enter into forward contracts. It is stated that consumers of English iron have recently been asking for deliveries to be delayed, but this is regarded as merely a temporary phase. There is no change to report in the prices of Scottish foundry iron, which are retained at the official minimum of 70s. for No. 3 foundry at furnaces, with 2s. 6d. extra for No. 1. There is no change in quotations for English iron, and No. 3 Cleveland is still being quoted officially at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow district. Other English foundry iron is 1s. 3d. per ton below these figures.

Coke

Although furnace coke has recently become a little cheaper, there is no weakness apparent in the cupola-coke market. Quotations for delivery in the Birmingham area remain as follow:—Best Durham coke, 36s. to 40s.; Welsh, 34s. to 43s. 6d., according to analysis; Scottish, 40s. to 41s. per ton.

Scrap

There is a strong demand for scrap iron in the Cleveland district, machinery metal being in good request at about 55s., whilst foundry cast-iron scrap is very strong at 53s., or possibly a shade more. Dealing has slackened off somewhat in the Midlands, but heavy machinery metal in handy sizes continues to be offered at 55s., good heavy pipe and plate scrap at 50s. and clean light metal at 47s. 6d. Good supplies of scrap are available in Scotland, and first-class machinery iron is unchanged at 55s. to 56s., with ordinary cast iron, in pieces not exceeding 1 cwt., at 51s. 6d. Heavy cast iron is not active in South Wales, a restricted business being done at 50s. to 51s. 6d., whilst good cast-iron machinery scrap in cupola sizes is only in limited demand at 52s. 6d. to 55s. per ton.

Metals

Copper.—The conference of copper producers in New York continues to attract attention. No information is yet forthcoming officially, but private advices indicate that a considerable measure of agreement has already been reached. It is reported that the African and South American mines are willing to restrict their production to 80 per cent. of the 1934 level as from May 1, and to 70 per cent. as from June 1 or July 1, provided that a restriction is placed on exports of North American copper.

As a result of this encouraging news, the market has shown a much firmer tone, and yesterday the quotation for standard metal rose to £30 2s. 6d.—the highest level reached since the beginning of the year. It is reported that consumers have bought a considerable amount of refined metal.

Daily quotations :—

Cash.—Thursday, £28 10s. to £28 11s. 3d.; Friday, £28 13s. 9d. to £28 15s.; Monday, £29 8s. 9d. to £29 10s.; Tuesday, £29 13s. 9d. to £29 15s.; Wednesday, £30 2s. 6d. to £30 3s. 9d.

Three Months.—Thursday, £28 17s. 6d. to £28 18s. 9d.; Friday, £29 1s. 3d. to £29 2s. 6d.; Monday, £29 16s. 3d. to £29 17s 6d.; Tuesday, £30 1s. 3d. to £30 2s. 6d.; Wednesday, £30 11s. 3d. to £30 12s. 6d.

Tin.—"Demand on the part of consumers generally has undergone some improvement, with a better inquiry on the Continent and a more active demand reported in the U.S.A. The market has not fully recovered from the unsettled conditions which have in the last weeks prevailed, but a steadier undertone is noticeable and the market meets with more resistance at the lower levels: moreover, a certain amount of support has from time to time been offered," report Messrs. Rudolf Wolff & Company.

The March issue of the Bulletin of the International Tin Research and Development Council reports that the short-term trend of world consumption is now upwards, by reason of the seasonal increase in the U.S.A. The long-term trend cannot be accurately predicted owing to its dependence to a large degree upon economic conditions in America, but the Bulletin contains charts showing moving averages of tin consumption for each country, from which it may be seen that there is a steady upward trend in the United Kingdom, Russia, Canada, Sweden, Denmark and Poland.

Market fluctuations :—

Cash.—Thursday, £209 10s. to £210; Friday, £212 10s. to £213; Monday, £215 10s. to £216; Tuesday, £216 to £217; Wednesday, £216 5s. to £216 15s.

Three Months.—Thursday, £206 5s. to £206 10s.; Friday, £208 15s. to £209; Monday, £211 to £212; Tuesday, £211 15s. to £211 17s. 6d.; Wednesday, £212 10s. to £212 15s.

Spelter.—On Tuesday the spot price of spelter on the London market rose to £13 5s. per ton—a new high level for the year. There has recently been quite a good demand for this metal, both from consumers and speculators. There has also been a keener demand from the Continent.

Official quotations :—

Ordinary.—Thursday, £12 13s. 9d.; Friday, £12 13s. 9d.; Monday, £13 3s. 9d.; Tuesday, £13 5s.; Wednesday, £13 5s.

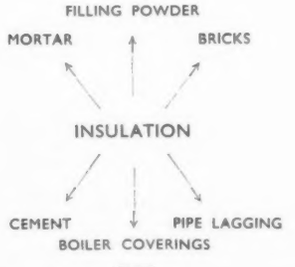
Lead.—It is anticipated that, as a result of the investigation into the duty on imports of foreign lead, it will be decided to allow dealings to take place on the London Metal Exchange on the basis that the duty is against sellers' account. The belief that this will bring about a recovery in prices is responsible for the optimistic tone now apparent in the market, and considerable buying has taken place. It is also reported that pipes and sheets, in addition to pig-lead, are in active request both here and on the Continent. The price level has steadily risen, and foreign lead touched £12 6s. 3d. per ton on Tuesday—the highest quotation yet recorded this year.

Day-to-day prices :—

Soft Foreign (Prompt).—Thursday, £11 13s. 9d.; Friday, £12 1s. 3d.; Monday, £12 5s.; Tuesday, £12 6s. 3d.; Wednesday, £12 2s. 6d.

MODERNISE YOUR FURNACES BY ADOPTING INSULATION

IMPROVED INSULATION AIDS EFFICIENCY



Let us Submit Specialised Data and Scheme for your own Particular Plant—Sent Free

KIMOLO SALES LIMITED
Terminal House, Grosvenor Gardens, LONDON, S.W.1.

SILICO MANGANESE SILICO ALUMINIUM
FERRO SILICON 25/30%
CALCIUM SILICIDE
SILICO SPIEGEL

FERRO ALLOYS

J. N. CLIFTON,
53, Victoria Street, Westminster, LONDON, S.W.

Telephone: Victoria 1852. Telegrams: Newclift, Sowest, London.

Sterling

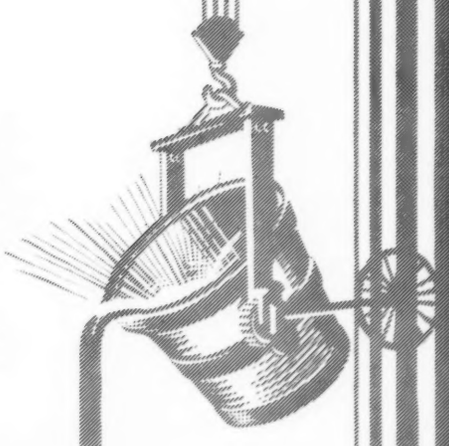
MOULDING BOXES

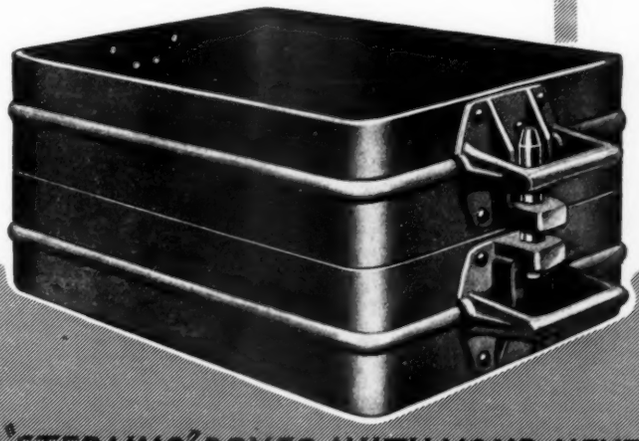
... are designed for the modern foundry

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently.

Sterling Boxes—Save their cost in a few months, and are obviously a sound investment for any foundry.





SPECIFY "STERLING" BOXES WITH YOUR NEXT ORDER

STERLING FOUNDRY SPECIALTIES LTD.

STERLING WORKS **BEDFORD**

LONDON OFFICE: 13 VICTORIA STREET, WESTMINSTER, S.W.1.

RAW MATERIALS—PRICE LIST

(Wednesday, March 27, 1935)

COPPER

	£ s. d.
Standard cash	30 2 6
Three months	30 11 3
Electrolytic	33 5 0
Tough	32 0 0
Best selected	32 10 0
Sheets	58 0 0
India	43 15 0
Wire bars	33 15 0
Ingot bars	33 15 0
H.C. wire rods	35 10 0
Off. av. cash, February	27 4 1½
Do., 3 mths., February	27 9 7½
Do., Sttlmnt., February	27 4 0
Do., Electro, February	30 8 6
Do., B.S., February	30 0 0
Do., wire bars, February	30 12 1½
Solid drawn tubes	9½d.
Brazed tubes	9½d.
Wire	6d.

BRASS

Solid drawn tubes	8⅜d.
Brazed tubes	10⅜d.
Rods, drawn	8d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7⅛d.
Wire	7d.
Rolled metal	6⅝d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£ s. d.
Standard cash	216 5 0
Three months	212 10 0
English	217 0 0
Bars	218 17 6
Straits	220 15 0
Australian (nom.)	—
Eastern	218 5 0
Banca	220 5 0
Off. av. cash, February	227 11 6
Do., 3 mths., February	223 15 7½
Do., Sttlmt., February	227 11 9

SPELTER

	£ s. d.
Ordinary	13 5 0
Remelted	13 10 0
Hard	11 0 0
Electro 99.9	15 15 0
English	14 10 0
India	12 15 0
Zinc dust	17 0 0
Zinc ashes	3 0 0
Off. aver., February	11 18 2¼
Aver. spot, February	11 16 4½

LEAD

	£ s. d.
Soft foreign ppt.	12 2 6
Empire (nom.)	13 5 0
English	14 5 0
Off. average, February	10 6 3⅜
Average spot, February	10 4 3¾

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	22 10 0
Do., V.M. ex-whse.	23 2 6
Rods	27 0 0

ANTIMONY

	£ s. d.
English	82 0 0 to 83 0 0
Chinese, ex-whse., (nom.)	72 0 0
Crude	—

QUICKSILVER

Quicksilver	£11 7 6 to £11 17 6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£12 15 0
75%	£17 17 6
Ferro-vanadium—	
35/50	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	3/– lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	£31 10 0
4/6% car.	£21 15 0
6/8% car.	£21 10 0
8/10% car.	£21 10 0
Ferro-chrome—	
Max. 2% car.	£34 0 0
Max. 1% car.	£36 5 0
Max. 0.70% car.	£37 5 0
70%, carbon-free	9¾d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/– to 5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d
Finished bars, 18% tungsten	2s. 2d

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales—	£ s. d.	£ s. d.
Heavy steel	2 15 0	to 2 16 0
Bundled shrngs.		2 7 6
Mixed iron and steel	2 10 0	to 2 11 6
Heavy cast iron	2 10 0	to 2 11 6
Good machinery	2 12 6	to 2 15 0
Cleveland—		
Heavy steel	2 11 6	to 2 12 6
Steel turnings		1 15 0
Cast-iron borings		1 5 0
Heavy cast iron		2 13 6
Heavy machinery		2 15 0
Midlands—		
Light cast-iron scrap		2 7 6
Heavy wrought iron		3 0 0
Steel turnings, f.o.r.		1 14 0
Scotland—		
Heavy steel		2 10 0
Ordinary cast iron		2 11 6
Engineers' turnings		1 19 6
Cast-iron borings	1 17 6	to 1 18 9
Wr'ght-iron piling		2 15 0
Heavy machinery	2 15 0	to 2 16 0

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	26 0 0
Brass	17 10 0
Lead (less usual draft)	11 0 0
Tea lead	8 0 0
Zinc	9 0 0
New aluminium cuttings	66 0 0
Braziery copper	22 0 0
Gunmetal	24 0 0
Hollow pewter	152 0 0
Shaped black pewter	105 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/–
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/–
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/–
,, No. 3 fdry.	71/–
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/–
,, fdry. No. 3	71/–
,, fdry. No. 1	74/–
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/–
Hem. M/Nos. d/d	71/–
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/–
Staffs fdry. No. 3	74/–
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 10 0	to 8 0 0
Hoops	10 10 0	and up.
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	and up.
Bolts and nuts, ¾ in. × 4 in.	14 2 6	and up.
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 5 0	to 9 7 6
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5½ in.		9 7 6
Rounds under 3 in. to ⅜ in. (Untested)		8 12 0
Flats—8 in. wide and over		8 12 6
,, under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)		9 7 0
Black sheets, 24g. (4-t. lots)		10 10 0
Galv. cor. shts. (,,)		13 0 0
Galv. flat shts. (,,)		13 10 0
Galv. fencing wire, 8g. plain		14 10 0
Billets, soft	5 10	0 and up.
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 0 0	to 5 7 6
Tin bars	5 2 6	to 5 7 6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11½d.
Rods	10½d.
Tubes	13d.
Castings	10⅜d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7¼
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/– to 30/–
,, furnace	19/– to 20/–
Durham foundry	19/– to 22/–
,, furnace	16/6 to 17/9
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14	per box	18/2 to 19/2
,,	28×20	,,	36/4 to 38/4
,,	20×10	,,	26/– to 26/3
,,	18¾×14	,,	18/6 to 18/9
C.W.	20×14	,,	15/6 to 16/6
,,	28×20	,,	33/– to 33/6
,,	20×10	,,	23/– to 24/–
,,	18¾×14	,,	16/– to 17/–

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 0 0 to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 0 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£30 0 0 to £31 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£ s. d.	
Mar. 21 ..	28 10 0 inc.	10 –
„ 22 ..	28 13 9 „	3/9
„ 25 ..	29 8 9 „	15 –
„ 26 ..	29 13 9 „	5 –
„ 27 ..	30 2 6 „	8 9

Electrolytic Copper

	£ s. d.	
Mar. 21 ..	31 10 0 inc.	10/–
„ 22 ..	31 15 0 „	5 –
„ 25 ..	32 10 0 „	15 –
„ 26 ..	32 15 0 „	5 –
„ 27 ..	33 5 0 „	10/–

Standard Tin (cash)

	£ s. d.		
Mar. 21 ..	209 10 0	dec.	25/–
„ 22 ..	212 10 0	inc.	60/–
„ 25 ..	215 10 0	„	60/–
„ 26 ..	216 0 0	„	10/–
„ 27 ..	216 5 0	„	5/–

Tin (English ingots)

	£ s. d.		
Mar. 21 ..	209 15 0	dec.	25/–
„ 22 ..	213 0 0	inc.	65/–
„ 25 ..	216 5 0	„	65/–
„ 26 ..	216 15 0	„	10/–
„ 27 ..	217 0 0	„	5/–

Spelter (ordinary)

	£ s. d.		
Mar. 21 ..	12 13 9	inc.	12/6
„ 22 ..	12 13 9	No change	
„ 25 ..	13 3 9	inc.	10/–
„ 26 ..	13 5 0	„	1/3
„ 27 ..	13 5 0	No change	

Spelter (Electro, 99.9 per cent.)

	£ s. d.		
Mar. 21 ..	15 3 9	inc.	11/3
„ 22 ..	15 3 9	No change	
„ 25 ..	15 13 9	inc.	10/–
„ 26 ..	15 15 0	„	1/3
„ 27 ..	15 15 0	No change	

Zinc Sheets (English)

	£ s. d.		
Mar. 21 ..	22 0 0	inc.	10/–
„ 22 ..	22 0 0	No change	
„ 25 ..	22 10 0	inc.	10/–
„ 26 ..	22 10 0	No change	
„ 27 ..	22 10 0	„	„

Lead (English)

	£ s. d.		
Mar. 21 ..	13 10 0	inc.	10/–
„ 22 ..	14 0 0	„	10/–
„ 25 ..	14 5 0	„	5/–
„ 26 ..	14 5 0	No change	
„ 27 ..	14 5 0	„	„

AVERAGE MONTHLY PRICES OF IRON HOOPS.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1899	7 0 0	7 0 0	7 0 0	7 0 0	7 12 6	10 12 6	8 12 6	8 12 6	8 12 6	9 2 6	9 7 6	9 17 6	8 2 9
1900	9 17 6	10 7 6	10 7 6	10 7 0	10 12 6	7 12 6	10 12 6	10 12 6	10 12 6	9 17 6	9 2 6	9 2 6	10 3 8
1901	9 2 6	8 2 6	8 2 6	7 12 6	7 12 6	7 12 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 11 2
1902	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1903	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 0
1904	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1905	6 17 6	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 2 6	7 2 6	7 2 6	7 7 6	7 0 0	7 7 6	7 2 0½
1906	7 10 0	7 17 6	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 7 6	7 15 1½
1907	8 7 6	8 7 6	8 7 6	8 7 0	8 7 6	8 7 6	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 0 0	8 7 1
1908	8 0 0	7 10 0	7 10 0	7 10 6	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 6 8
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
1910	7 1 10½	7 6 3	7 7 6	7 7 0	7 7 6	7 7 6	7 7 6	7 7 6	7 7 6	7 6 3	7 5 0	7 5 0	7 6 5
1911	7 5 0	7 5 0	7 5 0	7 5 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 8 9	7 10 0	7 6 3	7 6 3½
1912	7 12 6	7 12 6	7 12 6	7 15 0	7 15 0	8 2 6	8 2 6	8 2 6	8 12 6	8 12 6	8 12 6	8 15 0	8 2 3½
1913	8 17 6	8 17 6	8 17 6	8 17 0	8 17 6	8 17 6	8 17 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 12 6
1914	7 17 6	7 17 6	7 17 6	7 13 9	7 12 6	7 12 6	7 12 6	9 2 6	9 2 6	9 2 6	9 2 6	9 2 6	8 6 4½
1915	9 3 6	9 18 1	10 7 6	10 16 6	10 17 6	13 2 6	13 2 6	13 2 6	13 7 6	14 2 6	15 2 6	15 15 6	12 10 1
1916	17 2 6	17 2 6	17 2 6	17 6 3	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 6 1
1917	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1918	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1919	17 2 6	17 2 6	17 2 6	17 2 6	24 6 3	24 6 3	24 6 3	25 9 0	26 7 6	26 7 6	26 7 6	26 17 4	22 14 9
1920	28 0 0	28 12 6	33 15 0	35 5 0	35 15 10	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	36 17 6	36 17 6	35 14 9
1921	20 1 3	23 5 0	21 12 6	20 0 0	20 0 0	20 0 0	17 5 0	15 0 0	14 4 0	13 15 0	13 10 0	12 18 0	17 5 10
1922	16 5 0	15 13 9	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 4 6½
1923	14 0 0	15 0 0	15 0 0	15 0 0	15 6 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 16 0	14 15 0	14 18 3½
1924	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 13 9	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 12 4½
1925	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1926	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	12 10 0	12 10 0	14 3 4
1928	12 10 0	12 7 6	12 0 0	11 13 6	11 15 0	11 12 6	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 14 10½
1929	11 10 0	11 10 0	11 10 0	11 10 0	11 9 0	11 5 0	11 5 0	11 5 0	11 5 0	11 2 0	11 0 0	11 0 0	11 5 11
1930	11 0 0	11 0 0	10 16 3	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 16 4½
1931	10 15 0	10 15 0	10 15 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 11 3
1932	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1933	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1934	—	—	—	—	—	—	—	—	—	—	—	—	—
1935	10 10 0	10 10 0	10 10 0	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

LIMPET

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

COREMAKER wants job as Working Foreman or Chargehand. Iron and Ali. Oil-sand jackets and jobbing. Previous firms, Kent's, Luton; Rodney, Deptford.—35, The Drive, Felthain.

FOREMAN Coremaker, desiring change, offers services to employers in need of a live man; motor and oil engines; also foundry experience; supervision of male and female labour; good organiser, and output guaranteed: Midlands preferred.—Box 212, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SPECIALLOID LTD., FRIERN PARK, TALLY HO CORNER, LONDON, N.12, has a vacancy for a Night Foreman in their Aluminium Piston Foundry. First class men with extensive knowledge of Y Alloy and other Aluminium Alloy are invited to write for appointment, giving full details of experience.

LONDON Firm requires efficient Foundry Chemist, take over sales department core compounds. Only practical, experienced man willing travel, with sales connection and able to demonstrate, entertained.—Full particulars, salary required, in strict confidence, to Box 17555, c/o DAWSON'S, 129, Cannon Street, London, E.C.4.

IRONFOUNDRY TRADES.—Wanted, by old-established firm with large connection in Lancashire and Yorkshire, experienced Traveller for sale of well-known brand of pig-iron. Applicants must be well known to users in area named. State in confidence age, experience and salary required.—Box 210, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

A YOUNG MAN is required to act as Assistant to the Metallurgist of a company dealing with alloy castings, heat-resisting metals and hardening processes. Some practical works' experience desirable but not essential. Applicants must state age, experience, references and salary required.—Box 214, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TENDER

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF STORES, ETC.

THE Metropolitan Water Board invite Tenders for the supply of the undermentioned Stores and Services for periods of 6 and 12 months commencing June 1, 1935:—

Contract No.

1.—Bricks, Firebricks, Cement, etc.
8.—Iron and Steel.
9.—Bolts and Nuts, Screws, Files, Shovels, Steam Tubes, etc.
12.—Fuel Oil, Oil (Lubricating), Kerosene, Motor Spirit, Greases, etc
19.—Iron, Brass, Gun-metal and other Castings.
20.—G.M. Stopcocks and Ferrules, Outlets and Caps for Fire Hydrants.
22.—Timber.
23.—Maintenance of Weighing Machines.

Tenders must be submitted on the official forms, which may be obtained on and after Monday, March 25, 1935, from the Chief Engineer, by personal application at the Offices of the Board (Room 155) or upon forwarding a stamped addressed envelope (large).

Applicants should refer to the number of the Contract for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed in the manner indicated in the Form of Tender, must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, April 15, 1935.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue, E.C.1.
March 19, 1935.

MACHINERY

REQUIRED, suitable machine for mixing stiff semi-solid core compounds, not less than 1 ton capacity, with good facilities for emptying.—Reply, Box 17562, c/o DAWSON'S, 129, Cannon Street, E.C.4.

UTARD Hand-squeeze, Turn-over Moulding Machine, Type M.R.1, practically new, suitable to take boxes up to 16 in. square. Price £25.—Box 202, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ONE 3-ft. 0-in. Cupola for Sale, with drop-bottom, wind-belt and blower; in good condition. Cheap.—A. HAMMOND, 14, Australia Road, Slough.

FOR Sale, 6-ton Overhead Hand Travelling Crane, span 37 ft.; £30.—Apply, E. HIND, Imperial Works, South Bank-on-Tees.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

PNEUMATIC MOULDING MACHINES

406 Osborn Jolt Rollover.
78-in. x 48-in. Britannia Jolt Rollover.
58-in. x 52-in. Macdonald Jolt Rollover.
36-in. x 24-in. Macdonald Jolt Rollover.
24-in. x 16-in. Macdonald Jolt Rollover.
36-in. x 18-in. Tabor Jolt Rollover (Portable).
48-in. x 24-in. Tabor Jolt Rollover (Portable).
18-44 Type Nicholls Jolt Squeezer.
Several Small Jolt Pinlift Machines.
Several Plain Jolt Machines (all sizes).
Several Small Power Squeezers (Split Pattern).

ALL above are in stock.
are *tested* and guaranteed.
would be sent on approval.
are offered on deferred payment system if desired.
can be seen at work.

I am willing to accept other plant *in exchange*.

ALEX. HAMMOND,
14, Australia Road, SLOUGH

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

100-h.p. A.C. MOTOR (Westinghouse); 960 r.p.m.; slipring; pipe vent; switch, controller.
Vert. 3-throw PUMP (Hayward Tyler): 6½" dia. ram; 8" str.; 12,000 galls. p.h.; 100-ft. head; 4½" suc.; 5" del.
3 LANCS BOILERS, 30' x 8', 150 lbs. w.p.
Two first-class Secondhand Steel-framed BUILDINGS, each about 188' long x 57' span x 22' high to eaves.

Write for "Albion" Catalogue.

Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD

MACHINERY—*Continued.*

ONE Morgan 5-cwt. capacity Oil-fired C.A. Type latest-pattern Tilting Furnace. One Morgan Type P.3 150/200-lb. capacity Lift-out Furnace, oil-fired, latest type, new last year, complete with blower. Cheap.—ALEX. HAMMOND, 14, Australia Road, Slough.

FOR Sale, Jackman No. 4 Cupola, rated capacity 6/7 tons; in good condition; £75.—Apply, E. HIND, Imperial Works, South Bank-on-Tees.

MISCELLANEOUS

FOUNDRY SUPPLIES.—Our two lines, Wax Core Vents and Iron Cement. Highest qualities, lowest prices; quick despatch.—WILLIAM OLSEN, LIMITED, Cogan Street, Hull.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1934 edition. Price 42s. cloth bound, 52s. morocco. Order *YOUR copy NOW*.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

MOULDING MACHINES

406 OSBORN jolt rollover.
18"×36" TABOR rollover shockless (portable).
40"×30" TABOR rollover shockless.
TWO BRITANNIA No. 1 jolters.
HAND Machines taken in part payment for above or exchanged.

EXTENDED PAYMENTS ARRANGED.

SANDBLAST PLANTS

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories.
T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".
T.B. 1 Tilghman sandblast barrel.
Small Tilghman rotary table sandblast.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

WHEN THINKING OF
SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.

We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.

Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.

Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.